

NATURE

No. 4457

SATURDAY, APRIL 2, 1955

Vol. 175

C.U.K. - H06784 - 174 - RP305
CONTENTS

174

	Page
Research and Development in Britain	565
Bird Display. By Dr. L. Harrison Matthews, F.R.S.	567
A Study in Palaeontology. By Dr. W. E. Swinton	568
Obituaries of the Piltdown Remains. By Miles C. Burkitt	569
Treatise on Vitamins. By Dr. Leslie J. Harris	569
Emil Behring and Paul Ehrlich : Their Contributions to Science. By Prof. C. H. Browning, F.R.S.	570
Evolution of the Earth. By Prof. L. Hawkes, F.R.S.	575
Obituaries :	
Sir Charles Martin, C.M.G., F.R.S. By Dame Harriette Chick, D.B.E., and Sir Alan Drury, C.B.E., F.R.S.; Dr. Leslie J. Harris	577
Dr. W. W. Barkas. By Dr. J. M. Preston	578
Dr. C. W. Bellerby. By Dr. A. S. Parkes, F.R.S.	578
News and Views	579
Behaviour of the Living Cell. By Dr. R. J. Goldacre	582
European Association of Exploration Geophysicists : Meeting at The Hague. By A. T. Dennison	583
Theory of Plasticity. By Dr. M. R. Horne	584
Carnegie Institution of Washington : Report for 1953-54	585
Relationship of Science and Religion	586
Bursts of Radio Emission	586
Earthquakes during October 1954-January 1955	587
Formation and Characteristics of Laterite	587
Origin of the Virus-producing Chromatic Mass or Net of the Insect Nuclear Polyhedroses. By N. Xeros	588
Conductivity induced by X-Rays in Polyethylene Terephthalate : a Possible Insulator for Radiological Apparatus. By J. F. Fowler and Dr. F. T. Farmer	590
Letters to the Editors :	
Promotion of Incorporation of Amino-acids by Specific Di- and Tri-nucleotides.—Dr. Ernest F. Gale, F.R.S., and Joan P. Folkes	592
Anomeric Inversions by Glycosidases.—Dr. E. Ben-Gershom	593
Paper Electrophoresis of a Purified Specific Antibody.—Shevket Tekman and Ayzen Ugur	594
Neuromuscular Block caused by Acetylcholine.—Dr. S. Thesleff	594
Palatability of N-Oxides of Pyrrolizidine Alkaloids as a Factor in <i>Senecio</i> Poisoning.—Dr. R. Schoental	595
Antibody Formation in Humans against their own Stored Red Cells.—Dr. Merwin Moskowitz	595
Coagulation Mechanism of the Horse.—Dr. W. N. Bell, R. K. Archer and S. C. Tomlin	596
Pseudocholinesterase in Pacinian Corpuscles.—Catherine Hebb and Kenneth J. Hill	597
Formation of Leuco-Anthocyanins in Eucalypt Tissues.—W. E. Hillis	597
Relative Reactivities of Substituted Anthracenes towards the Addition of 2-Cyano-2-propyl Radicals.—E. Farenhorst and Dr. E. C. Kooyman	598
Use of 'Dieldrin' to protect Wool against Insect Attack.—M. Lipson and R. J. Hope	599
Tanning of Blowfly Puparia.—Dr. M. G. M. Pryor	600
Cytological Contributions to the Phylogeny and Classification of the Rodent Genus <i>Gerbillus</i> .—Dr. J. Wahrman and A. Zahavi	600
Influence of Impurities on the Growth of Quartz Crystals from Flint and Quartzite.—C. S. Brown, R. C. Kelt, P. Middleton and L. A. Thomas	602
Dielectric Properties of Pinacol Hydrate : Application to Temperature Measurement.—J. S. Dryden and Dr. R. J. Meakins	603
Pulsation and Mass Transfer of Pendent Liquid Droplets.—Prof. F. H. Garner, O.B.E., Dr. C. W. Nutt and M. F. Mohtadi	604
Age of Uraninites from Crystallographic Data.—Henry R. Hoekstra and Joseph J. Katz; Dr. B. Wasserstein	605
Age of the Mineralization of the Witwatersrand.—Dr. C. F. Davidson, O.B.E.	606
A New Joule Manuscript.—L. L. Ardern	606

DIFCO

Antigens for Laboratory Detection of Syphilis

Bacto Antigens are prepared expressly for the laboratory detection of syphilis by means of complement-fixation, precipitation, and flocculation tests. Each antigen is tested for its sensitivity and specificity in a laboratory designated for that purpose by the author serologist of the test for which it is specified. Bacto Antigens are not released for distribution unless they have been so approved.

BACTO-BJL FLOCCULATION ANTIGEN
BACTO-BJL WASSERMANN ANTIGEN
BACTO-EAGLE FLOCCULATION ANTIGEN
BACTO-EAGLE WASSERMANN ANTIGEN
BACTO-HINTON CARDIOLIPIN INDICATOR
BACTO-HINTON INDICATOR
BACTO-KAHN CARDIOLIPIN ANTIGEN
BACTO-KAHN SENSITIZED ANTIGEN

BACTO-KAHN STANDARD ANTIGEN
BACTO-KOLMER CARDIOLIPIN ANTIGEN
BACTO-KOLMER IMPROVED ANTIGEN
BACTO-KOLMER IMPROVED ANTIGEN (Reinforced)
BACTO-VDRL ANTIGEN
BACTO-ANTISHEEP HEMOLYSIN
BACTO-COMPLEMENT

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

Sole Agents for Great Britain

BAIRD & TATLOCK (LONDON) LTD.
FRESHWATER ROAD, CHADWELL HEATH, ESSEX

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

*World's Largest Stockists
of Scientific Periodicals*

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading
Universities, Public Libraries
and Institutions of the World.
Catalogues issued.

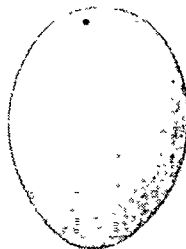
SELLING?

Specialists in Scientific,
Technical Books and
Publications of all
Learned Societies.

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1

Telephone: Wel. 7943, Amb. 5991

**FERTILE HENS' EGGS**

*Large or small numbers always
available for research or production*

DAY-OLD CHICKS
GROWING PULLETS, COCKERELS
AND HENS

supplied for experimental or routine work

N. W. WITHERS
Appleby Farm
EGERTON · ASHFORD · KENT

TELEPHONE: PLUCKLEY 247

RESEARCH AND DEVELOPMENT IN BRITAIN

ALTHOUGH the financial provision for research and development in 1955-56 set forth in the Statement on Defence 1955 is about the same as 1954-55, the very magnitude of that expenditure—some £837 million gross—quite apart from the demands that the programme makes on the scientific and technical man-power of Britain, at the least prompts the question whether this effort is in balance with other equally essential demands on the nation's resources of man-power and materials, as well as of finance. The demands of defence must be considered along with those of the programme for nuclear power and of the proposals for the modernization of railways and roads which have also recently been laid before Parliament. Even where no secrecy considerations enter, it is not easy to obtain a clear picture: defence research and civil research are closely interlocked in many fields in addition to that of nuclear energy, and the task of striking a sound balance is far from easy, no matter how closely the Advisory Council for Scientific Policy and the Defence Research Policy Committee are co-operating.

The nation's scientific and technical resources will undoubtedly be stretched to the limit to meet the demands made upon them by the proposals laid before Parliament this session; there will certainly be no room for overlapping of effort or waste of resources. It will be imperative to see that the structure of the nation's research organization is efficient and effective, that it is competent to secure prompt action to redress any weakness that threatens at short term or long range to endanger the national effort. The shortage of science teachers and the position of technical education might be cited as two examples, particularly as they illustrate how any adequate survey must take account not simply of economic resources, industrial and academic research, but also of the conditions which determine the appropriate flow of recruits, at all levels where they are required, to industry and to the university departments, as well as to government departments and the Services. Not can there be any room for organizations or institutions that are no longer giving full value to the nation, or that are fulfilling functions which would now be more effectively served in other ways.

It has been apparent from the number of Parliamentary questions in recent months that the House of Commons has been particularly vigilant in respect of the Department of Scientific and Industrial Research, while the debates last year on the Development of Inventions Bill clarified considerably the functions of the National Research Development Corporation. Parliament was satisfied in these debates that adequate arrangements were made to prevent overlapping in the development of inventions between the research associations and government departments, and that the extension of the Corporation's borrowing powers for a further five years would not lead to competition between the Corporation and industry or other government

departments, but enable the Corporation to promote research and development where it was needed, and was otherwise unlikely to be undertaken. The Corporation's functions were also explained in a number of addresses last year, notably by the Earl of Halsbury to the Royal Society of Arts.

Nevertheless, the Corporation has done well to devote the major part of its fifth annual report* to a general stocktaking of the Corporation's functions and its position in the national economy in the light of its first five years' work (see also *Nature*, March 26, p. 541). The review leaves little doubt as to the value of the Corporation, even if its real functions are more limited than was originally supposed, or at the time when Sir Henry Tizard gave his Messel Memorial Lecture in 1952. When the Corporation was formed, it was thought that a single organization for dealing with the exploitation of discoveries or inventions made in government departments or in semi-official research organizations would offer real advantages. It was also believed that the existence of a public body which could assume the responsibility for effecting liaison between centres of learning and research on one hand, and industry on the other, would meet a real need and enable science to be applied to industry and agriculture at an accelerated rate. Thirdly, it was believed in some quarters that full exploitation of the inventive talent of Britain was in part frustrated by lack of support for inventors, particularly amateur inventors without industrial connexions.

It is this third expectation that appears to have been falsified. The Corporation's five years' experience has not shown that a multiplicity of meritorious private inventors stand in need of public assistance. One or two good inventions from private sources receive its support each year, and the Corporation may be right in regarding as justified the work involved in assessing the merits of such inventions and the money expended on their development. Outside the field of light engineering and instrument manufacture, it concludes, the isolated individual rarely appears to have any serious contribution to make to the advancement of technology.

The absence of meritorious proposals in the various fields of physics, chemistry, biology, medicine and the non-mechanical branches of the engineering sciences could equally, however, be due to industry being quicker to recognize promising ideas and to outside financial assistance for the private inventor being more easily available than was supposed after the War. Certainly the Corporation's reports afford no support for fears that industry is relying on government bodies for development in matters where the initiative should lie with industry itself. Too much may have been expected of the Corporation in some directions, and equally some of the fears entertained have proved groundless. The Corporation has

* National Research Development Corporation Report and Statement of Accounts for the year 1st July, 1953, to 30th June, 1954. Pp. 20. (London: H.M. Stationery Office, 1955) 9d. net.

experienced no difficulty in obtaining first-class opinion on the technical merits of any proposal coming before it, and where such opinions have been favourable, it has accepted its obligation to act upon them. Moreover, in agreement with its advisers, it has made small beginnings in untried fields and has in consequence spent much less than was originally provided to finance its activities.

The demonstrable field for the Corporation's activities lies in the development of government inventions and those made by other public research bodies. The Corporation believes that the needs of this group have largely been met. The Corporation is now administering on commercial lines some thousands of British and foreign patents and patent applications, and these patent rights are beginning to earn revenue which should rise slowly but steadily with the years.

A major difficulty encountered by the Corporation has been to decide whether a proposal before it should be viewed as research having for its object the making of a new invention, or as research having for its object the development of an invention already made. Such difficulties tended to arise wherever joint enterprises between the Corporation and the public research establishments were contemplated. The wider powers given in this respect by the Development of Inventions Act, 1954, have removed this uncertainty, and while it is unlikely that many new projects will be called into existence, it will be easier in future for the Corporation to decide whether a given project falls inside or outside its statutory functions.

The Corporation has also encountered a major difficulty through the injunction to entrust the exploitation of inventions "to persons engaged in the industry concerned", an injunction which does not extend to development. The Corporation may, for example, place a development contract with a firm not in the industry; but a licence for manufacture, special circumstances apart, may only be given within the industry. A development contract thus placed tends on one hand to bring a contract into the industry and to create a "special circumstance" in the special knowledge and skill acquired by the contractor. Moreover, the more novel an invention is, the less obvious it is which of various industries can fairly claim to be the industry most concerned. The Corporation has taken the view that it is required to avoid introducing unfairly competitive elements into a recognized industrial pattern; but not, where no clearly defined pattern exists, to avoid all initiative for fear of changes which profound novelty must introduce.

The Corporation is not a trading concern, although since an isolated development contract unrelated to sufficient initial orders to test the market has proved an inadequate means of securing its aims, the Corporation has sometimes found it essential, with the approval of the Board of Trade, to give contractors sufficient initial orders to enable them to undertake production. This has been done notably with the electronic digital computers, for which the Corporation has underwritten both development and initial stages

of production. Apart, however, from any profits derived from the Corporation's initial interest in commercial manufacture and sales thus underwritten, its only assets are the patent rights in the inventions which it runs, and under which it grants licences in consideration of royalty payments. These are wasting assets with a useful life of sixteen years, and it is probable that a further five years will be required before the Corporation's financial prospects can be reasonably assessed.

Despite this caution, the Corporation is convinced that its work serves a useful purpose at a relatively modest cost. The report points out that industry is less homogeneous and continuous than is frequently supposed. This probably provides the Corporation with its greatest opportunity, next to the exploitation of government inventions, by establishing communications between two parties to a discovery which affects them both, as happened when the Medical Research Council discovered that waste sisal juice was a relatively copious source of hecogenin, a possible starting point for the synthesis of steroid hormones such as cortisone. There were no pre-existing lines of communication between the sisal plantations of the tropics and the pharmaceutical industry of Great Britain, and no means by which the former could ascertain whether the latter would, in fact, wish to use hecogenin, while the latter had no hecogenin for experiment and thereby to establish a price which it could offer. The Corporation commissioned a pilot plant in Kenya, underwrote a full-scale plant to be erected on a sisal plantation in Tanganyika, contracted for the output and placed a development contract for the refining process before firms in the pharmaceutical industry had given any clear indication that hecogenin would be wanted.

That within two and a half years of the Medical Research Council's discovery a British firm has been enabled to begin small-scale production of cortisone in the United Kingdom based on hecogenin produced in East Africa and the West Indies may well seem sufficient justification for the existence of the Corporation. The argument that there is a special service to be rendered to the community in this context is not invalidated by the fact that the original expectations in regard to cortisone have been disappointing. The urgency was there, and the clinical value could not be established until sufficient supplies were available for trials on an adequate scale.

This example sufficiently indicates the importance of the work of the National Research Development Corporation becoming widely known. The survey of the relations between industry and science in the Greater Manchester area made by the Manchester Joint Research Council left the impression that the Corporation was not yet sufficiently widely known to play effectively the part it was created to fulfil. The Corporation's expenditure, even its consolidated balance sheet, looks trifling compared with the national expenditure of approaching £200 million on civil research and development and of £837 million on defence production and research; but it is none the less essential that full use should be made of the Corporation's services wherever appropriate.

That is, of course, one particular aspect of the broad problem of securing the widest dissemination of knowledge and the effective utilization of research results by industry. It may be recalled that the last annual report from the Advisory Council for Scientific and Industrial Research referred particularly to the relations of the Corporation with the research associations. Some research associations are already using the Corporation as the normal agent for the development of inventions. Others, such as the cotton industry, the coal utilization and the electrical and allied industries research associations have adopted the policy of forming analogous companies to take over their inventions and discoveries for development on a business basis. Such a system has the advantage of relieving a director of research and his staff of responsibilities which may be outside their normal training and experience, and transferring them to a board of directors and management experienced in the financial and economic problems involved in development. It presupposes, however, that a board and management of the requisite experience and sound judgment can be found, and it also ignores the possibility that development problems, while onerous, may not be without value in widening the outlook and experience of a director of research and his staff and consolidating his judgment in the selection of problems for research.

The real lesson to be drawn from this quinquennial review of the work of the National Research Development Corporation's work, and the reason for discussing it at length, are the demonstration the review affords of the value of a critical and constructive review of all aspects of the nation's research effort at a time when it is being kept at full stretch. Only by such means can we be sure of eliminating inefficiency or waste, and of making the necessary adjustments when one function becomes obsolete or is better served by other means. That is particularly true when the functions of an organization appear to be changing, as, for example, with the research organizations, the educational functions of which have since the War come to assume much greater importance, both from the point of view of introducing new ideas and new knowledge to industry and of training technical and scientific staff.

For this reason alone it is reassuring to learn that special surveys of the resources, programmes and facilities of the research associations are proceeding, though it would clearly be unreasonable to expect effort to be expended on more than one or two such surveys at any one time. Nevertheless, there is some reason for believing that direction at a higher level is not so clear or so far-sighted as is desirable. This could be sensed in the last annual report of the Department of Scientific and Industrial Research, and in the meagreness with which the office of the Lord President of the Council is staffed, as well as in the continued absence of a direct spokesman for the Lord President in the House of Commons.

It is still more apparent from the reply given by Mr. J. R. Bevin, Parliamentary Secretary to the Ministry of Works, on behalf of the Lord President, when questioned about the cutting down of oper-

ational research by the Building Research Station. The Government believes that productivity in the building industry has increased by about ten per cent in the past four or five years, and that operational research in the industry is now not so necessary. This reply will leave the ordinary citizen unconvinced. There is no need to look far for evidence that, whatever the general increase in productivity since 1950-51, it has not been general throughout the industry, and it does not balance the loss of efficiency since 1939. The industry compares badly in this respect with some other industries, and is notoriously backward in adopting the new techniques, materials and practices which the work of the Building Research Station and other advances in scientific knowledge have put at its disposal.

We are thus concerned with something more than the climate of opinion to which Lord Salisbury referred in the speech read in his absence by Mr. Selwyn Lloyd at the annual luncheon of the Parliamentary and Scientific Committee. That Committee could well help, as Lord Salisbury suggested, to create an outlook more favourable to the utilization of science in industry, and the wider employment of scientists and technologists in managerial positions. It could also help with the task of securing a wider dissemination of the knowledge of technical developments and the results of scientific research, as well as in securing a continuous and practical approach to the problem of overcoming the human obstacles to innovation at all levels. But the Committee's first task, and one which no other body could so effectively discharge, may well be to see that the Government keeps constantly in mind the necessity of seeing, not merely that adequate resources are available for scientific and industrial research and development, but also that the organization by which these resources are administered and co-ordinated is appropriate and adequate to its purpose, used with energy and vision and intelligence and continuously reviewed in the light of changing national needs. It should at least see that the right questions are asked about the distribution of Britain's research effort, about its organization and financing as from public and private sources and about the recruitment of trained man-power and the supplies of equipment and material. More than most other bodies, it has the status to ensure that reasonable answers to such questions are forthcoming from the Government.

BIRD DISPLAY

Bower-Birds

Their Displays and Breeding Cycles—a Preliminary Statement. By Mr. A. J. Marshall. Pp. x+208+27 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 30s. net.

DR. MARSHALL has been studying the biology of the bower-birds, both in the field and the laboratory, for the past twenty years, and has published a number of papers upon the subject from time to time during that period. In this volume he collects together the accumulated results of his own researches,

together with everything that is known from other sources about the lives of the bower-bird. The result is an admirable book which the author modestly calls "a preliminary statement" and a "basis for further research", and which forms a valuable contribution to scientific ornithology.

The bower-birds, which with the cat-birds form the family Ptilonorhynchidae, are passerine birds of moderate size confined to Australia and New Guinea; they have long been known to build display grounds and to decorate them with various brightly coloured or otherwise conspicuous objects. The bower is built on the ground and has no direct connexion with the nest, which is made in a tree, often at a considerable distance. Some species even paint their bowers with fruit-pulp, wet charcoal, or comminuted dry grass mixed with saliva, and one species makes a 'paint brush' to help it apply the decoration. The bower of another species, decorated with living orchids, may reach a height of nine feet; and a gardener bower-bird of New Guinea builds a hut and plants a meadow of moss before it which is decorated with coloured fruits, flowers and fungi. On the display ground of the spotted bower-bird of Australia, coins, jewellery, car keys and other decorations stolen from human habitations are sometimes found. Most of the species are strikingly skilful vocal mimics of other birds, and their noisy and spectacular displays often take place outside the breeding season.

In the literature that has grown up about the activities of the bower-birds, it has become accepted that the motive for making and using bowers is a consciously aesthetic one, that sexual motivation has little or no part in bower-building and the associated phenomena, and that the birds 'play' at playgrounds rather than display. The author shows that such ideas are no more than anthropomorphic nonsense, and that apart from purely descriptive matter little that has been written about the behaviour of the birds can withstand critical inquiry. As a result of his histophysiological studies, Dr. Marshall shows that "these complex and remarkable phenomena are probably expressions of innate behaviour patterns that are annually brought into play by the secretion of sex hormones during the period of pre-nuptial testis modification, which begins at approximately the same time each year, except in birds that inhabit dry areas of spasmodic and uncertain rainfall. . . . The display, which may continue for months, attracts and retains the female's interest, keeps off rivals, and helps synchronise the male and female reproductive processes until, when the environment becomes seasonally appropriate for nesting and the rearing of young, fertilization occurs and the female goes off to build her nest and to rear her young without masculine assistance".

In his chapter on the evolution of bower-building, the author points out that sexual display is universal throughout the class of birds, and that display-grounds are used by many species, as, for example, the black-cock and the ruff. He suggests that the extraordinarily elaborate display grounds of the bower-birds are no more than a special and very interesting case of this widely spread phenomenon, in which the similarities are examples of convergent evolution. Even within the family Ptilonorhynchidae the development of display mechanisms has evolved independently in the bower-birds and the cat-birds, and the similarities are the result of convergence.

The author devotes separate chapters to describing all that is known of each species of the family, but

gives more space to the satin bower-bird than the others, for this is the species which has been most available to him for experimental work. His book is of great value in correlating field observation with histophysiological work in the laboratory, and is a splendid example of the best modern trend in the study of natural history. There are numerous excellent illustrations. L. HARRISON MATTHEWS

A STUDY IN PALAEOLOGY

Life of the Past

An Introduction to Paleontology. By George Gaylord Simpson. Pp. xii + 198. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1953.) 4 dollars.

ANY work from the pen of Prof. George Gaylord Simpson merits attention, whether it be geographical, statistical or palaeontological. He is so much at home in so many fields and in so many languages that one may at times be apt to forget that his descriptive palaeontological work is unsurpassed. By that I mean to imply that he sees both the wood and the trees and he never forgets the implications of either.

This present volume is perhaps the least serious of his recent writings. He has lately managed to survey evolution in a way that would have given most authors the right to a pause in their labours, so presumably this might be expected to be a classic, though a lesser classic. Instead of this, I venture to suggest that it is one of the most important palaeontological works that has appeared for some time, because it contains precisely what the student should bear in mind when he approaches the study of the past forms of life. It may be well and astonishing that one take the shell or a bone of a long-gone animal and tell its name and its age. It could be impressive if one were able to do this with a great number of fossils, and it would yet be possible for such a geological exhibitionist to have very little idea of the circumstances of the past.

To understand the true nature of a specimen, one must realize the age in which it was placed; the geography of the time; its animal and plant competitors; the whole to be seen against the background of its predecessors and successors and on the scale of time.

This is more or less what Simpson does here. Using the ample resources of the United States for most of his examples, he discusses the evidence on the ground and proceeds to explain how the evidence got there. Step by step he describes the reconstruction of the once-living animal from its shell or skeleton, and builds up the communities in which it lived. It is then easy to discuss the evidence that collections of fossils give as to the geological and zoological nature of the past. Knowing how an animal is constructed and the place where it was adapted to live enables one to derive a good idea not only of its complete anatomy but also of its physiology and therefore of its degree of adaptability.

With this kind of information one can speculate not only on the diversity of life but on its essential ability to diversify.

This leads naturally to the discussion of organic change and the theories of evolution; but the whole is done in comparatively direct and simple language.

and with a wealth of reference to interesting observations and discoveries that the author has made. For those who demand something more for the examination table, there is a short appendix of the forms of life arranged systematically. There are also a list of books suggested for further reading and a good index. Indeed, the only thing one can complain about are the illustrations, which are unnecessarily sketchy and crude for a book that is otherwise produced on a standard commensurate with its price.

W. E. SWINTON

OBITUARIES OF THE PILTDOWN REMAINS

Further Contributions to the Solution of the Piltdown Problem

Bulletin of the British Museum (Natural History): Geology, Vol. 2, No. 6 (1955).

The Piltdown Forgery

By Dr. J. S. Weiner. Pp. xii+214+8 plates. (London: Oxford University Press, 1955.) 12s. 6d. net.

THE Piltdown saga has now been concluded. The British Museum (Natural History) has brought together under the title "Further Contributions to the Solution of the Piltdown Problem" in its Bulletin (Vol. 2, No. 6) the views of a large number of specialists who have described their work on the specimens—work which has resulted in demonstrating without any doubt that the whole thing was a hoax. This is an important publication, as we have here, clearly set out, the methods now at our disposal to check discoveries, and are shown how they demonstrate that the Piltdown finds were not genuine. These methods have to some extent been perfected as a result of the Piltdown re-investigation, and to that extent the 'hoax' has been useful. The late Sir Arthur Smith Woodward had not these methods of study at his disposal and therefore cannot be blamed for having failed to spot the imposition. Unfortunately, he had casts made almost at once, which were mainly used by savants when studying the specimens. No cast, however well made, can give the minute scratches such as those which in the case of the teeth were of great significance. I was a youngster at the time and never a 'bone' man; but I was one of a not too numerous band who was allowed to handle the originals in Smith Woodward's room at the Museum soon after they had been presented at a meeting of the Geological Society. But even if I had had the knowledge to judge the matter, it would not have occurred to me to question their authenticity.

Dr. J. S. Weiner's book, "The Piltdown Forgery", deals rather with the many personalities in the case. For this reason it will have a very popular appeal. It is exceedingly well written and gives one a vivid picture of the group of keen amateurs, most of them friends of old Ben Harrison, of Eolithie fame, who were concerned at the time with Sussex geology and archaeology. We are led relentlessly to one conclusion, which, though it can never be absolutely proved, is the only one which fits the facts. The story unfolds with the discovery of Piltdown I, and we find not a few of the local amateurs a little suspicious that all is not as presented. We now have evidence for staining of specimens; we have the 'happy' find of Piltdown II which was to clinch the

matter. There was even more in the background which never appeared until much later.

It all reads like a novel, and I have no intention of spoiling it for others by saying more. It is a book to be read with interest and profit. Such a hoax nowadays is impossible; but it was one actually perpetrated and it was a great success.

MILES C. BURKITT

TREATISE ON VITAMINS

The Vitamins

Chemistry, Physiology, Pathology. Edited by W. H. Sebrell, Jr., and Professor Robert S. Harris. Vol. 1. Pp. xiii+676. Vol. 2. Pp. xii+766. Vol. 3. Pp. xiii+665. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) Vols. 1 and 2, 16.50 dollars each. Vol. 3, 15 dollars.

DURING the second half of 1954 these three volumes have appeared in quick succession, and the series is now complete. It is a monumental undertaking, and will immediately take its place as a standard reference work, and source book, for everyone doing research on the biochemistry of vitamins. The scope of the enterprise is apparent from the fact that Vol. 1, running to 676 pages, has four chapters dealing with vitamin A, vitamin C, vitamin B₁₂, and biotin; Vol. 2 in 766 pages, covers six further vitamins (choline, D, "F", inositol, K, nicotinamide and pantothenic acid), while Vol. 3 in 665 pages takes up the topics of PABA, folic acid, B₆, riboflavin, B₁, E and other factors.

Each chapter in turn contains a dozen or so sections, by separate authors, dealing successively and systematically with such matters as nomenclature, chemistry, industrial preparation, biochemical systems, specificity of action, biogenesis, assay, standardization, distribution in foodstuffs, effects of deficiency in animals, deficiency in human beings, pharmacology, pathology, requirements of animals, and human beings, and even "future problems". The individual sections are further split up into sub-sections, and these into sub-sub-sections. There is no doubt that this is far and away the most comprehensive treatment of the subject that has so far appeared in a single treatise. Nevertheless, it is not exhaustive. The clinical manifestations of vitamin deficiency and their treatment are not described in any detail, nor are the methods of vitamin assay, the reason given being that these matters are already fully dealt with elsewhere.

The undertaking is essentially American. (In Vol. 1 seven of the eleven authors are from the United States, two from Germany, and two from Britain. In Vol. 2 of the nineteen authors, seventeen are American, and the remaining two Canadian. In Vol. 3, twenty-two authors are American, and one is Dutch.) It is a consequence of this fact, perhaps, that in several of the sections the bibliography does not quite fairly cover the whole of the international scene, but deal too exclusively with the American literature, which is presumably more accessible but, chronologically speaking, not always the 'first in the field'. All the same, any serious investigator desiring to make contact with the existing scientific literature could not do better than start the search with "Sebrell and Harris". We owe a debt of gratitude to the editors and to the authors for their most successful endeavour.

LESLIE J. HARRIS

EMIL BEHRING AND PAUL EHRLICH

THEIR CONTRIBUTIONS TO SCIENCE

By PROF. C. H. BROWNING, F.R.S.

Emeritus Professor of Bacteriology, University of Glasgow

MARCH 14 and 15, 1954, marked the hundredth anniversaries of the birth of Paul Ehrlich and Emil Behring—two men whose achievements have had a profound effect on the trend of biological science and medical practice in the past fifty years. Biographical accounts of them and bibliographies are readily accessible; it need only be noted that both came from the German middle-class and apparently neither stock had any close medical connexions. Here an attempt is made to place their chief contributions in the perspective of their own time as well as the present day.

EMIL BEHRING

Behring made the great discovery of the class of biological products known as antibodies. In 1890 he published along with Kitasato evidence that the soluble poison (toxin) of the tetanus bacillus, when injected into the tissues of living susceptible animals under conditions appropriate for developing immunity, leads to the appearance in their blood serum of the property of neutralizing the toxin. This was attributed to the development of 'antitoxin', the first example of an antibody which is produced in response to the stimulus of an antigen, here the toxin. Diphtheria toxin behaves similarly. Shortly before this, Roux and Yersin had proved that the pathogenic effects of diphtheria bacilli are completely reproduced in susceptible animals by injecting their toxin; and the same is true of tetanus. (The term 'toxin' or 'exotoxin' was applied to crude fluid cultures of the organisms rendered sterile by passage through fine-pored filters; but recently progress has been made in obtaining chemically pure toxins, which are of protein nature.) A quantity of toxin which is a large multiple of the fatal dose can be rendered innocuous by the previous addition *in vitro* of an appropriate amount of antitoxin. Further, antitoxic serum when injected into a normal individual renders the latter immune, such immunity being termed *passive* in contrast to the *active* immunity of the animal which has received the toxin. Thus, clearly an animal which has been treated by injections of toxin is immune to the disease in virtue of developing the antitoxin. Antitoxin has curative, as well as protective, action, because after injecting a dose of toxin which otherwise would be fatal, it is possible to save life by afterwards administering antitoxin, although the length of the permissible interval is limited. The phenomena were recognized as being specific, since diphtheria antitoxin does not confer immunity against tetanus or vice versa.

The practical implications of Behring's work for medicine were rapidly grasped. At that time diphtheria was a very prevalent and highly fatal disease in Europe and America. Treatment with antitoxin was soon established, and although there may be few recorded series of trials which would satisfy strict statistical criteria, the opinion among physicians of its high therapeutic value quickly became practically universal. The efficacy of tetanus anti-

toxin in preventing tetanus in man was confirmed on an impressive scale in the First World War. In 1901 Behring received a Nobel Prize for his pioneer work on serum therapy, especially against diphtheria; he was also created von Behring. Apparently his earliest research, on iodoform, then regarded as a valuable drug in the local treatment of pyogenic infections, but now fallen into disuse, suggested that for effective therapy of an infection it was not essential that the causal organism should be killed by the medicament, and in antitoxins he saw the evolution of this principle. It must be noted, however, that relatively few species of pathogenic bacteria act in virtue of producing powerful exotoxins, and therefore only a limited number of infections are capable of being effectively countered by antitoxins.

Behring's later investigations were largely concerned with tuberculosis, especially active immunization by vaccines which he prepared; they did not yield valuable results. He recommended a mixture of diphtheria toxin and antitoxin for active immunization of the human subject against diphtheria, which proved effective. Owing to risks in use, it has been superseded by safer preparations containing toxoid, especially toxin treated with formaldehyde, which destroys its toxicity without damaging the antigenic properties. As will be seen later, treatment by diphtheria antitoxin became a practical success largely through Ehrlich's work on standardizing its potency; his method of test ensured that the products were, in fact, effective.

The discovery of antitoxin and its spectacular action in diphtheria greatly stimulated inquiry into immunity mechanisms. Various other manifestations of antibody action were disclosed and antibody formation was found generally to accompany acquisition of immunity to pathogenic organisms or their products. The demonstration that antibodies may be necessary in order to render certain virulent organisms susceptible to phagocytosis reconciled the humoral theory of immunity with Metchnikoff's cellular doctrines. The fact that antibodies can be developed to a number of foreign substances which are innocuous, for example red blood corpuscles of other species, proved that they are a product of biological reaction of the tissues which has no necessary connexion with disease. It is of great interest also that natural antibodies occur, for which no known antigenic stimulus can be traced. Antigens usually contain protein, and it is the rule that to be effective they must escape degradation in the alimentary tract, hence generally they must be introduced parenterally. The investigation of antigens and antibodies has developed into an active department of science in its own right, serology, which has yielded many important applications in addition to therapy, for example in diagnosis of the species of animal products, identification of micro-organisms and the recognition of infections which they cause, as well as elucidation of the morbid manifestations

associated with allergy and hæmolytic diseases. The remarkable specificity of antigen-antibody reactions in a physical-chemical sense dominates this field of inquiry.

PAUL EHRLICH

Ehrlich was an incessant worker: from 1877 on he made outstanding original contributions, and although the last publications under his own name appeared in 1913, there is no sign that his intellectual faculties were failing. However, he used to complain of the sterilizing effect of controversy, when the objections of others compelled him to devote attention to matters which he considered to be settled. In 1914, to commemorate his sixtieth birthday, there appeared under the title "Paul Ehrlich" an account of his scientific work. The sections of this *Festschrift* which treat of special topics are by thirty-one authors, and there are more than six hundred titles of papers in the names of Ehrlich, members of the staff or visitors in his laboratories. As he died in the following year, this is almost a complete record.

Waldeyer, the anatomist, told how he once came on Ehrlich when a medical student in his second semester and a beginner in histology, staining preparations with various dyes which Ehrlich himself had selected for trial. This incident gives the keynote to his life-work—chemistry devoted to furthering biological knowledge. The chemistry was from choice that of the organic dyes, a branch rapidly developing in Germany at the time in industrial as well as academic laboratories. The biology, while it ranged widely, comprehended especially mammalian physiology and pathology. Ehrlich was no man's disciple; he was mainly self-taught, and largely created his own fields of research. At first the laboratory work was done by his own hands; but by the beginning of this century the control of a large institute at Frankfurt-am-Main, as well as the financial support of friends, afforded ample official and unofficial assistance. Even then, however, he did not desire the numbers which are now not uncommon; he wished no more than he could completely share working experiences with, and avoided "many doves flying in and out". His formulations of theory, although often hammered on the anvil of his assistants' brains, were his own creations.

Ehrlich's subjects of investigation may be arranged more or less in chronological periods, but the earlier studies, such as those on staining of the blood cells, made the least demands on material resources. Then came the investigations on toxin and antitoxin, which culminated in an accurate method of standardizing diphtheria antitoxin. Out of this arose also the statutory control of antisera and other biological products used in medicine, which was a main function of the *Königliches Institut für experimentelle Therapie*. This led to other investigations on immunity mechanisms made possible largely by the tools which Bordet's discovery of hæmolytic immune sera provided. In addition, Ehrlich devised the side-chain theory to account for the action of toxins on the basis of his conception of normal processes of nutrition and to explain the development of antitoxins and other antibodies. The theory aroused the widest attention and met with immediate and almost universal acclaim. Ehrlich's reputation had now gained the standing which made it possible to undertake his cherished plans for chemotherapy. This was the most expensive of his researches in the demands

on materials and skilled assistance in chemistry and various departments of pure and applied biology. Investigations on cancer were carried out largely in response to the wishes of public and private supporters and proceeded concurrently with studies on immunity and chemotherapy. Chemical research went on throughout, and was in later times his only handiwork.

Ehrlich, like Faraday, was above all a born experimenter. His principle of work is illuminated in a quotation from his notes translated in Miss Marquardt's book as follows: "During my work as a student I repeatedly tried to follow up certain lines of thought by experiment. But I did not succeed in carrying out a single one of my ideas in this way. Soon, however, I came to try the other way round, that is to say, not to give directions to Nature but simply try to analyse striking experimental facts which were difficult to understand and by so analysing to find the laws which governed the action". The initial stages would appear 'empirical' to some, but so is all exploration unless informed by the best scientific practice of the time, as Ehrlich's emphatically was. His deep knowledge of both chemistry and biology enabled him to recognize associations hidden from others.

Tinctorial Analysis

Until late in the 1880's Ehrlich's research consisted chiefly of *Farbenanalytische Studien*. His first discovery was that the connective tissue contains cells packed with large granules which have an affinity for basic organic dyes; the granules are also metachromatic, acquiring a tint different from that of the cell nuclei or the dye in aqueous solution. Dahlia, dissolved in a suitable mixture of water, alcohol and acetic acid, stains only these granules. Thus for the first time—excepting madder and bone—a selective histochemical reaction for a normal tissue constituent was got; this contrasted with previous morphological staining by carmine, etc. The cells were called mast cells (from the German for 'feeding up' of animals), because they are specially numerous in 'overnourished', that is, stimulated, connective tissue. Ehrlich subjected the leucocytes to similar examination, using dried blood films one cell thick and fixing them by heat, as in Koch's procedure for bacterial cultures. The films were stained with 'triacid' and other dye mixtures which Ehrlich devised. He distinguished, in addition to basophils, specific lines of eosinophil (acidophil) and neutrophil granular leucocytes, as well as non-granular forms. This laid the foundation of morphological hæmatology and permitted an exact classification of the leucocytoses—and hence correct inferences as to underlying causes—and the differential diagnosis of leukemias. The composition and exact functions of the various granules have not yet been fully elucidated. Mast cells contain stores of heparin and histamine, also perhaps hyaluronic acid³; the eosinophils and neutrophils are rich in oxidase and the latter contain proteolytic enzymes⁴; but beyond that little is known. Studies of the nucleated and non-nucleated red blood corpuscles enabled megaloblastic and aplastic anæmias to be separated from the commoner normoblastic type associated with what is now called hypochromic anæmia. The examination of the red bone marrow, so valuable an adjunct to blood examination, is a direct development of Ehrlich's original work. Another important discovery of this period was the application of

methylene blue as a highly selective stain for micro-organisms, with little affinity for tissue elements except nuclei and mast-cell granules. Also, the acid-fast property of the tubercle bacillus was demonstrated; without it the microscopic examination of pathological materials for this organism would have remained an academic accomplishment, instead of becoming one of the simplest, as well as most reliable, diagnostic procedures.

Vital staining, which we owe to Ehrlich, constitutes a fundamental advance in the methods of studying the tissues of the living animal. He recognized the great biological significance of being able, as it were, to mark constituents of normal cells in full functional activity and not merely inspect them *post mortem*. Certain dyes in solution are taken up in characteristic fashion without producing any obvious harmful effects. Thus methylene blue (and some other thiazine dyes) on injection into the circulation colours ganglion cells, nerve fibres and endings—why some of them remain unstained is not clear, although Ehrlich suggested that a lowered alkalinity and oxygen-saturation were factors. Vital staining with methylene blue provided a new means for investigating the microscopic anatomy of the central nervous system and yielded valuable results. Neutral red, also a basic dye and very little toxic, stains granules, so far of undefined constitution, in various tissue cells, but nuclei are coloured only after cell-death. Some acid dyes, such as isamun blue, trypan red and trypan blue, are taken up especially by the histiocytes, and conspicuous stained droplets appear in the cytoplasm. As these cells have the property of ingesting micro-organisms and other solid particles, it has been surmised by later workers that the 'segregation apparatus' acts as an immunity mechanism and may have an important association with antibody production.

In "Das Sauerstoff-Bedürfnis des Organismus" (1885), Ehrlich tackled the problem of comparing the oxygen requirements of tissues in the living animal. The work, which was tentative and speculative, broke new ground by means of a novel experimental method, namely, the introduction into the tissues of dyes capable of reversible reduction and oxidation; but differing in the ease with which reduction from the coloured to the leuco form can be effected. In order to obtain satisfactory results it was found necessary to use compounds of very low solubility in water, which, however, yield colloidal solutions, and the degree of dispersion is an important factor for the staining. The dyes were alizarin blue, which is reduced to the colourless form with difficulty, and indophenol blue, which is easily decolorized; the energy required is, of course, capable of measurement. Both compounds circulate in the blood in the coloured state. After administration of the substances (in toxic doses) to rabbits, etc., the animals were examined at an appropriate time. The organs were inspected on removal immediately *post mortem* to avoid changes in the dyes occurring later, and they were parboiled or squashed between glass plates to reduce the masking effect of their natural colour. The following findings relate to circumstances where flooding of the circulation with dye has been obviated and the respective organs have a considerable affinity for it. The heart, cerebral grey matter and striped musculature do not reduce alizarin blue and so are stained (although reduction of the dye occurs soon when the organs are kept in the air). The same is true of indophenol blue, except that it is reduced

by certain striped muscles. Accordingly, those tissues are in a high state of oxygen saturation during the life of the animal. On the other hand, the lung, kidney-cortex and liver, as well as, in the cat, adipose tissue, reduce alizarin blue; consequently, these are much less saturated with oxygen. It should be noted that no tissue which reduced alizarin blue *in vivo* failed to reduce indophenol blue. Ehrlich's conclusions that there exist in the body sites with such different affinities was opposed to the view of Pflüger that all tissues are in a state of saturation with oxygen. The above is a bare summary of some of the more clear-cut experimental data and their discussion. The following quotation from the section headed, "Considerations on the fundamental properties of protoplasm" is important, since it states the essence of the side-chain theory: "we may accept that in living protoplasm there is a central grouping of special structure which determines the peculiar and specific activity of the cell, and also that atoms and atom-complexes are attached to this grouping as side-chains, which are of subordinate importance so far as the specific function of the cell is concerned, but not for its collective life".

Immunity

Investigations on immunity (1893–c.1903) comprised work on toxins, their constitution and mode of action, the development and structure of antitoxins, the standardizing of diphtheria antitoxin and the side-chain theory, followed by studies on cytolytic antisera, especially haemolysins.

After Behring and Kitasato's discovery of antitoxins the question remained undecided whether the neutralization of toxin by antitoxin is a direct reaction between the two or, since the test object is a living animal, it may depend on some essential biological factor operated by the latter. Ehrlich found that the poisonous plant proteins, ricin, abrin, etc., develop antitoxins in animals; and the haemagglutinating property of ricin for a saline suspension of red blood cells *in vitro* is abolished when antiricin serum has been added to the ricin beforehand. A mixture which is neutral as assessed in this way is also devoid of toxicity for test animals. This was the first instance of the use of test-tube experiments in the investigation of a problem in immunity. These facts provided strong evidence that antitoxin acts directly on toxin, the proof being completed by Martin and Cherry.

As already mentioned, the clinical use of diphtheria antitoxin was hampered at first by lack of a method for ensuring that potent sera were available. Ehrlich applied his experience of antiserum production to securing a proper plan of dosage of toxin in the animals to be immunized; also, the use of horses was adopted, as at the Institut Pasteur. He then devised a method of standardizing antitoxin which has remained in practically universal use to the present day. Many specimens of diphtheria toxin were prepared and tested in animals. Guinea pigs of medium weight (250 gm.) were found to be very uniformly susceptible, so that with a specimen of toxin the minimum lethal dose, that is, that causing death acutely, could be accurately estimated. However, the lability of toxin on keeping precluded its use as a permanent standard. Mixtures of a fixed amount of toxin (a considerable multiple of the minimum lethal dose) with varying amounts of antitoxin were tested in parallel and the smallest amount of serum required to neutralize the toxin was ascer-

tained. Supposing that x c.c. of antitoxin were required to neutralize 50 minimum lethal doses, then 10 x c.c. were necessary to neutralize 500. Accordingly, the law of constant proportions holds, and this is true over a wide range of dosage. Different specimens of toxin were tested with a given antitoxin and it was found that the number of minimum lethal doses neutralized by a fixed amount of the serum might vary considerably. Antitoxic serum, when dried and kept *in vacuo* in a cool dark place, retains its potency unchanged for an indefinitely long time; therefore, it is suitable as a standard. The unit is the smallest amount which completely neutralized 100 minimum lethal doses of the toxin originally used, when the mixture in constant volume was injected subcutaneously. But afterwards it proved more practicable to use a mixture containing sufficient excess of toxin to cause death in four to five days, that is, a mixture containing the equivalent of one minimum lethal dose free (animals which survive for this period live for some time, for example weeks or longer). This end-point is more readily determined than complete neutralization as defined by total absence of symptoms and lesions.

The procedure in titrating a new specimen of antitoxin is as follows: (1) ascertain the minimum amount of an available specimen of toxin which is neutralized by one unit of the standard antitoxin to the extent that animals receiving the mixture die on the fourth to fifth day; this is the test dose of toxin; (2) ascertain the maximum volume of the new antitoxin which neutralizes similarly the test dose of toxin; this volume then contains one unit of antitoxin. As was shown later by others, the titrations can be carried out more economically and rapidly by injecting the mixtures in small amount intracutaneously; the amount of toxin used is the least which when injected along with, say, 1/500 unit of antitoxin produces a minimal inflammatory reaction of the skin at the site. Afterwards Ramon demonstrated that when toxin and antitoxin are mixed *in vitro* under suitable conditions, flocculation occurs and, in general, when varying amounts of antitoxin are added to a fixed volume of toxin, that mixture which first shows flocculation corresponds with the neutral point as ascertained by Ehrlich's method. Owing to certain anomalous results, however, the *in vitro* procedure cannot replace animal titration. The flocculation reaction has revealed that one antitoxic serum may cause flocculation more rapidly than another, although the unitage of both may be the same, that is, the 'avidity' of the two differs. Ehrlich's view has been widely accepted that the curative value of an antitoxic serum corresponds with its unitage as measured by his method. Now it is conceivable that differences in avidity might affect the curative action, a less avid serum being the less efficacious, and this has been stated, although substantial evidence on the point is lacking.

Regarding the mechanism of the reaction between toxin and antitoxin, Ehrlich concluded that they behave as substances with strong chemical affinity. Certain experimental findings have to be reconciled with this view, namely: (1) the effect of partial saturation of toxin by antitoxin—if a series of mixtures containing a fixed multiple of the minimum lethal dose of toxin with increasing fractions of the neutralizing dose of antitoxin are tested for toxicity, in general, the smaller amounts of antitoxin neutralize relatively more toxin than the higher amounts; (2) the Ehrlich phenomenon—the difference between

the amount of toxin which is just neutralized by one unit of antitoxin and that which when mixed with the same amount of antitoxin proves lethal in 4–5 days, that is, behaves as if it contained one minimum lethal dose of unneutralized toxin, always exceeds one minimum lethal dose and often is much more; (3) the Danyez phenomenon—a fixed amount of antitoxin neutralizes more toxin when the latter is added all at once than when the toxin is added in several portions at intervals. Ehrlich regarded these facts as evidence that crude toxin consists of a mixture of components with differing toxicity and combining affinity; he applied the name toxoid to constituents which are devoid of toxicity, but retain the capacity for combining with antitoxin. Two further points were emphasized by Ehrlich: (4) he stated that the addition of a small initial amount of antitoxin might leave the toxicity unaltered; to explain this he postulated the presence of some toxoid (prototoxoid) with a higher affinity for antitoxin than that of the toxin; (5) the late occurrence of paralysis, etc., in animals which had received 'neutral' mixtures of toxin and antitoxin was attributed to a special poorly neutralizable toxic component of crude toxin, which he called toxone. Prototoxoid has been dismissed by critics as an error of observation—a fault to which Ehrlich was not prone. The effects attributed to toxone appear to have been reproduced by prolonged administration of toxin alone in minute doses. Ehrlich insisted that those who held that crude toxin contains a single toxic component neglected the habitual complexity of biological products, as, for example, the mixture of related alkaloids in opium.

Arrhenius and Madsen interpreted the first two findings as indicating a mass action effect between substances of weak affinity. The Danyez phenomenon is incompatible with this view. Bordet regarded neutralization of toxin by antitoxin as an adsorption phenomenon without fixed quantitative relations. In the absence of pure preparations of the reagents, the controversy is in abeyance. But the existence of toxoid has been fully substantiated and it can be produced by the action of formaldehyde on toxin. Also, the toxin-antitoxin combination, while more or less reversible in recent mixtures, for example by dilution, becomes firm later; the toxin, however, is not destroyed by the reaction, but can be dissociated by alteration of pH, etc.

Side-chain theory. As mentioned above, Ehrlich regarded the molecule of protoplasm as being furnished with side-chains (later called receptors); certain of these (nutroreceptors) have the function of maintaining the life of the cell by combining with food molecules. If substances such as toxins, which, as now appears, are actually proteins, in addition to being able to combine with receptors by means of their haptophore groups, also are poisonous, that is, possess a toxophore group, then the cell will be damaged. The damage may be sufficient to kill the cell, but short of this the cell will survive and may be stimulated to produce excess of similar receptors, according to Weigert's law of hypertrophy in response to functional demands. Finally, these receptors, instead of remaining attached to the cell (sessile), may become free in the circulation. Here the free receptors will combine with the specific toxin which stimulated their development and so act as antitoxins by neutralizing the toxin before it reaches the cellular protoplasm. This hypothesis embodies a pharmacological principle that chemical substances

(toxin or drug) in order to act on living cells must first combine with them. As expressed by Ehrlich, "*corpora non agunt nisi fixata*". In the case of dyes, the site of fixation can be recognized by the eye; and he strove to obtain dye derivatives of alkaloids which would retain their characteristic pharmacological action, but met with little success. It is of interest that Grotthus and Draper had made a similar statement from their observations on photochemical effects.

Failure to extract antibodies in quantity from any organ or tissue has so far prevented their identification with sessile receptors; but several facts support the view. Thus, after bleeding an immunized animal at a static phase of antibody production, there is an accession of antibodies to the blood; again, the supersensitiveness of blood-free tissues in animals rendered actively anaphylactic, as well as the phenomenon of delay in establishing passive anaphylaxis, are scarcely explicable except on the basis of sessile receptors (see below). (Evidence from the use of 'markers' is omitted until more is known as to the ways in which they may be distributed in the constituents of the body.) No evidence negatives the theory. It fell into disrepute after the first rather uncritical enthusiasm for it. But now knowledge that antibodies most probably are globulins and inquiry into the sites of globulin production have caused it to be seriously considered again, and recent diagrams of the complementary coils of protein molecules recall Ehrlich's visions of fifty years ago re-dressed according to modern chemical fashion. One objection to the theory, namely, that antigens, which are largely proteins, so far from being analogous to normal nutrients of the cells, are usually intruders into the body as infective agents or artificially introduced parenterally, has been answered by the work of Whipple. He has produced the strongest evidence that free entrance of protein to the interior of cells does occur. The high specificity of antibodies for the corresponding antigens was accounted for by Ehrlich on the supposition that a receptor pre-existed for each antigen. At present it is explained by the antigen acting as a sort of template for the pattern of the globulin antibody. This still leaves the problem unsolved as to how, like a 'paternal impression', the influence of the antigen can persist long after it has presumably disappeared.

Ehrlich recognized in Bordet's discovery of hæmolytic antisera an invaluable instrument for analysing *in vitro* both qualitatively and quantitatively the mechanism which also underlies bacteriolytic and bactericidal action; and by this means, too, he obtained further insight into the properties of receptors. Essentially, as Bordet showed, the cytolytic effect depends upon an antibody, which is specific and thermostable at 55° C., co-operating with complement (alexin), which is a non-specific constituent of normal serum and plasma, not increased by immunization and thermolabile; both act quantitatively and complement disappears in the process. The fact that the antigens of the red corpuscles reside in the stromata and so are particulate enabled absorption experiments to be carried out by Ehrlich; for example, a suspension of corpuscles freed from their native serum by repeated centrifuging with isotonic saline was added to heated antiserum and after a time the mixture was centrifuged; the supernatant was then tested for its content of antibody and likewise the sediment, after washing with saline. Cells, antisera and com-

plements from many animal species were examined in conjunction and the temperature of the suspending fluid varied at different stages. Thus, it was found that the antibody is fixed by red cells at temperatures down to 0° C., whereas at the latter point complement is inactive in the presence of antibody and fails to be fixed. Complement is not fixed at 37° C. in the absence of antibody. Depending on the species of the red corpuscles and of the animal yielding the antibody, complement of a particular species may fail to cause lysis, that is, may be 'non-dominant'. (Muir showed afterwards that such failure may be due either to non-combination of the complement or to lack of toxicity in the particular circumstances.) Ehrlich called the hæmolytic antibody an amboceptor, since he conceived that it had two haptophore groups and so acted as a link between the receptor of the antigen and the complement, enabling the zymotoxic or ergophore (toxophore) group of the latter to attack the red cell. In the absence of conclusive evidence of its linking action, Bordet preferred to call the antibody a sensitizer. Muir, on finding that antibody alone could be dissociated from sensitized red cells which had been saturated with complement (and lysed in the process), used the term 'immune body' for an antibody which along with the corresponding antigen leads to combination of complement—which may or may not be followed by cytolytic action.

The chemical basis of specificity of receptors, rather than the biological, was emphasized by Ehrlich: this is well illustrated by the finding that a hæmolytic immune body developed in the rabbit by ox blood corpuscles also leads to lysis of sheep's corpuscles by complement; but absorption experiments show that it contains two moieties, one fixed by both species of red cells, the other only by those of the ox.

The hæmolytic agent in certain normal sera, for example that of the guinea pig for ox corpuscles, has the same double constitution. When red cells of one individual were injected into others of the same species a hæmolytic immune body developed in certain cases; this was called an isolyisin. Therefore, individuals differ sufficiently to enable certain receptors of one to exert an antigenic stimulus (*ictus immunisatorius*) in others. But isolyisins developed by the same blood corpuscles in different individuals can be shown by absorption experiments not to be identical. Hence the receptor apparatus of the recipient determines which receptors of the donor will act as antigens. Attempts to produce an autolysin by injecting an individual with his own blood failed. This protective mechanism, *hæmophilic autotoxismus*, as Ehrlich called it, may break down, however, as in paroxysmal hæmoglobinuria *e frigore* (where the lytic antibody unites with the red cells only when the temperature falls below 37° C.). This form of hæmoglobinuria is usually associated with syphilis. Some cases of hæmolytic anæmia, a condition which now claims much attention, are also due to autoantibodies. The nature of the derangement which brings about autolysin formation is unknown, but recently it has been shown that the presence of an 'adjuvant', such as a killed culture of tubercle bacilli, may stimulate the development of antibodies to substances which by themselves would not act as antigens.

The question whether antibodies act as antigens was partially resolved by confirming Bordet's demonstration of 'antiamboceptors' which prevent union of complement. On the other hand, the apparent

existence of anticomplements was later shown by Moreschi to be simulated by a Bordet-Gengou reaction. Thus, on injection of foreign serum, an antibody is produced; *in vitro*, this along with the serum fixes complement, the indicator being sensitized red corpuscles added later, which remain intact. The delicacy of this test for determining the species of serum and certain other proteins in amounts of the order of less than 1 γ exceeds that of the precipitin reaction. The work of Neisser and Sachs on this subject in Ehrlich's laboratory emphasized its practical value, the most outstanding instance of which is the Wassermann reaction.

Theobald Smith directed attention to the observation that guinea pigs which had survived the injection of a mixture of diphtheria toxin and antitoxin from the horse became severely ill and often died when they received a large dose of horse serum at a later date. But animals which had originally received a massive dose of serum alone (to confirm absence of harmful constituents) usually withstood the second dose. Analysis of the "Theobald Smith phenomenon" by Otto in Ehrlich's laboratory and by others showed that this form of supersensitiveness, called anaphylaxis, has as its basis the antibody reaction set up by the original minute dose of foreign serum, and that it

is specific and essentially independent of the toxin, although the latter may be an adjuvant. Anaphylaxis can be transferred passively. This work played a large part in emphasizing the importance of allergic phenomena in disease.

Ehrlich's 'wet nurse experiment' in mice demonstrated that transmission of antitoxic immunity to the offspring occurs only through their ingesting the milk of an immunized female, which contains the antibody—but in some species there is transplacental transfer. Thus the immunity of the young is passive. There is no hereditary transmission of acquired humoral immunity either from the father or mother.

In 1908 Ehrlich shared with Elie Metchnikoff the Nobel Prize for Medicine "in recognition of his work on immunity".

¹ Engelhardt, A. v., "Emil von Behring", *Behringwerk-Mitteilungen*, 10 (Berlin, 1940); MacNalty, A. S., *Brit. Med. J.*, 1, 668 (1954).

² Apollant, H., et al., "Paul Ehrlich" (Jena, 1914). Marquardt, M., "Paul Ehrlich" (London, 1949). "Paul Ehrlich Centennial", *Ann. New York Acad. Sci.*, 59, 141 (1954) (includes assessments by various authors of Ehrlich's work and present-day developments). Himmelfeit, F. (ed.), "The Collected Papers of Paul Ehrlich" (London, 1954).

³ Raley, J. F., *Lancet*, 3, 841 (1954); *Nature*, 174, 318 (1954).

(To be continued)

EVOLUTION OF THE EARTH

A JOINT discussion of the Geological and Royal Astronomical Societies was held in the apartments of the Geological Society at Burlington House on February 2 to consider problems discussed by the late Dr. G. M. Lees in his presidential address to the Geological Society in 1953—"The Evolution of a Shrinking Earth" (*Quart. J. Geol. Soc.*, 109, 217-257; 1953). This address was not primarily concerned with "The Origin of the Earth", the advertised title of the discussion, and only one speaker, Mr. T. Gold, related his remarks to that problem. Unfortunately, many who came to listen—and some to speak—failed to gain a footing in the overcrowded meeting room.

Prof. L. Hawkes, in opening the discussion, said that Dr. Lees had challenged some conceptions regarding the earth's crust which are widely held by both geologists and geophysicists; in particular, his view that there may be no fundamental difference between the basement of the oceans and the continental masses could not be accepted. It has been firmly established, first by geologists and later by geophysicists, that the rocks beneath the oceans are denser than those in the upper part of the continental crust. The discovery by the seismologists of the Mohorovičić discontinuity (the 'Moho'), where lighter material overlies denser material, has given precision to the picture, and provided a convenient definition of the 'crust' as comprising the rocks above the 'Moho'. The 'Moho' is probably world-wide, and no significant difference has been found in the velocities of shock-waves in the sub-Moho material beneath the oceans and that beneath the continents. In two areas in North America, H. E. Tatel, L. H. Adams and M. A. Tuve (*Proc. Amer. Phil. Soc.*, 97, 658-669; 1953) have failed to find the 'Moho', and it may be that in orogenic disturbances some mixing of lower crust and mantle may take place. Although the earlier conception of a continental crust composed of sharply defined horizontal layers of different density is now known to be erroneous, the term 'granitic

layer' is still useful in directing attention to a feature of the continental crust which is absent or only sparingly present in the oceanic areas. The oldest rocks known include sediments transported by and laid down in water, which indicates the presence of oceans at the beginning of geological time. The difficulty in finding a satisfactory theory for the ocean-continent relationship may lie in the fact that it was established in pre-geological time and perhaps by processes which have not been operative since. There is evidence that throughout geological time there have been continents and oceans, a crust behaving under stress as it does now, igneous material with the same variable composition coming up from below, a similar temperature to that of the present, and perhaps life existing throughout. The geologist sees no vestige of a beginning. The remarkable uniformity of crustal conditions and happenings for, say, the past three thousand million years is a fact which must find a place in the speculations of the cosmologist.

Mr. T. Gold discussed the formation and internal development of an earth formed by the agglomeration of solid particles—a model more acceptable to astronomers than the scheme of an originally liquid earth. From a cloud of dust and gas, lumps of solid are formed which aggregate through collision into a large mass bearing the scars of impact, a method of growth fitting the interpretation of the lunar features. In such a model various sources of heat are available—the compression of the interior causing a temperature rise of perhaps 2,000°, the attenuation of seismic waves caused by the impacts, and radioactivity causing a gradual rise of 2,000° or 3,000° in three thousand million years. During growth and afterwards, this heating causes a certain amount of melting; everywhere liquid will be mixed with solid long before complete melting could occur. A structure of pores or veins of liquid results, and a transport of liquid depending upon density may occur. The core

of the earth may have arisen in this way by the downward percolation of dense liquid—molten iron or other substances metallic at the pressures. Lighter liquid penetrating upwards may have supplied the atmosphere, the oceans and the crust. The transport of liquid upwards being prevented by the lower temperature of the crust ('thermal blockage'), vulcanism is only possible where there are fractures sufficiently large to alter the thermal structure. Quickly changing stresses resulting from the percolation of liquid from one level to another give rise to earthquakes, a series of shocks rather than single events being the rule. The same type of process is considered responsible for the major deformations of the crust. The internal flow and hydraulic actions to be expected from the model give new freedom for explaining the major problems of earth structure and movement.

Prof. C. E. Tilley commented that, although cosmology is not the province of the geologist, he has a right to express a view as to how matter in the deeper crust and upper mantle is likely to be organized if the earth had passed through the liquid state, and to discuss the implication of Mr. Gold's model. Mr. Gold would have difficulty in explaining the gross layering of the earth's interior without assuming extensive fractional melting. Geologists have been unable to accept the geophysical concept of sharply defined upper and intermediate layers of the crust, and it is reassuring, he said, to have the pronouncement of H. E. Tatel, L. H. Adams and M. A. Tuve that the crust above the 'Moho' in North America may be about as irregular and inhomogeneous as the rocks exposed in the Basement Complex area. In the Canadian Shield, Dr. Lees had estimated thicknesses of at least 200,000 ft. involved in tectonic belts—much exceeding the accepted crustal layer of 40 km.—yet the 'Moho' had been found at that depth in Minnesota. The 'Moho' could reasonably be associated with a change to ultra-basic material of peridotitic composition. Occurrences of peridotite at St. Paul's Rocks on the mid-Atlantic Ridge, dredged samples of serpentine from south-west of the Azores, and the basaltic serpentine 'in place' on the Gettysburg Bank between Gibraltar and the Azores are of significance in ocean areas where the 'Moho' is at a relatively shallow depth. Is it not probable, Prof. Tilley asked, that the mylonized peridotite of St. Paul's Rocks is a fragment from beneath the 'Moho' brought up in a great line of fracture? Recent measurements of heat flow under the oceans have emphasized our lack of knowledge of the radioactivity of oceanic rocks. Petrology and geochemistry, through their recently developed experimental techniques, could contribute in increasing measure to the common problems of geology and geophysics.

Sir Edward Bullard said we cannot at present explain even in principle how the earth has developed to its present state, and that what matters in a synthesis is not whether its details will prove correct but whether it relates the known facts in a way that suggests fresh investigations and experiments. The needs of the petrologists, the measurers of gravity and the seismologists are reconciled in the present accepted picture. The 'granitic layer' of the seismologists can be equated with the 'basement complex' of the Pre-Cambrian and the 'intermediate layer' softened to a gradual and regionally variable increase in the proportion of basic rocks with depth. It seems likely that the 'Moho' represents a boundary below which the complications of surface geology do not extend. The 'Moho' must represent a change of

material and not a phase change, since the pressures and temperatures concerned are within the range accessible to laboratory experiment, and such a conspicuous change in a common type of rock could scarcely have escaped attention. The behaviour of continental structures at the boundary to the ocean is of critical importance. Dr. Lees assumed that the structures continued out to sea and that the continental rocks must likewise continue. It seems unlikely, Sir Edward said, that the forces which produced a mountain range on the continent would have stopped short sharply at its edge. It does not follow, however, that the continental rocks continue beyond the edge; the material on which the mountain-building forces act may be different, and continental features usually have no topographic continuation on the floor of the deep sea—as can be seen, for example, from the Hercynian mountains of Europe and the extension of the Appalachians across Newfoundland.

In the open discussion following the four principal contributions, Sir Harold Jeffreys, commenting on a criticism in Dr. Lees's address, said that mathematics is as much a tool as the geologist's hammer or microscope. It tests whether suggested explanations do explain, and it has the property that its methods are always open to inspection. There is no satisfactory ground for believing that the folding measured in mountains is identical with the crustal shortening. Mr. M. W. Strong directed attention to the amount of folding that can be accounted for by local rearrangement of rock masses associated with batholithic intrusions rising and thrusting the sedimentaries aside much in the manner of a salt-plug, but on a vaster scale. Prof. R. M. Shackleton also questioned Dr. Lees's inference of immense crustal compression. Although the oldest visible rocks generally dip at high angles, it does not follow that the crust has suffered general compression. Some of the oldest parts of the crust, for example Southern Rhodesia, show structures primarily due to the rise of granite plutons between which sediments have been sucked down.

Summing up the discussion, Prof. O. T. Jones referred to the view that a continental layer of 35–40 km. could not accommodate in their visibly crumpled form the vast thicknesses of sediments in certain regions, and he pointed out that the effect of one period of diastrophism might have been obliterated before the beginning of the next period of deposition. What remained is a small fraction of that originally laid down and may thus be accommodated without assuming an excessive thickness of crust. It is difficult to arrive at an estimate of the total shrinkage of the earth from the continental areas alone. Mr. Gold's model of a sponge-like interior of rock and metal, he said, does not bear any close relation to any earth with which the geologist is familiar. It does not seem to explain the separation of oceanic and continental areas, nor does it seem to account for the long narrow belts of crumpled strata arising from compression at various times. Although it is said to account for volcanic activity in providing a source of molten material near to the surface at any time, it does not provide an explanation of the long belts along which volcanoes are strung out. The discussion had been of value, however, in the pooling of ideas and in emphasizing the need for new evidence regarding the earth's interior and behaviour and for more accurate data on the properties and materials of the earth's crust.

L. HAWKES

OBITUARIES

Sir Charles Martin, C.M.G., F.R.S.

CHARLES JAMES MARTIN was born in London in 1866. He received his early education privately and later entered King's College, London, before going to St. Thomas's Hospital, where he qualified in medicine. He was a brilliant student, winning many distinctions, and was a gold medallist and University scholar in physiology. For a time he studied at the University of Leipzig under Karl Ludwig. Shortly after qualification, in 1891, he went out to Australia and after holding junior posts in the departments of physiology at Sydney and Melbourne, became professor of physiology at Melbourne in 1901—the year in which he was elected to the fellowship of the Royal Society.

His work over a period of twelve years in Australia not only showed that he was a potential research worker of great ability but also a man who could inspire and initiate work in varied fields. He exerted a great influence on medical education and is acknowledged as one of the founders of medical research in that country.

In 1903 Martin returned to England to become the director of the Lister Institute of Preventive Medicine. He had such a profound influence upon the development of the Institute that he may be said to have created it and was largely responsible for the high quality of its scientific work and the large number of scientists who were trained during his directorship.

In the interruption caused by the First World War, he joined the Australian Army Medical Corps and received the rank of lieutenant-colonel. He organized the laboratory pathological services for the Gallipoli campaign and dealt with the difficulties connected with amoebic and bacillary dysenteries and the typhoid fevers. This work was later continued in Egypt and Palestine. In 1917 he went to France, where he organized and directed the pathological department for the 23rd General Hospital of the British Royal Army Medical Corps at Rouen. He was twice mentioned in dispatches and was made C.M.G. for his war service.

When, in 1930, he retired from the directorship of the Lister Institute, he accepted the invitation of the Australian Council of Scientific and Industrial Research to take temporary control of the Institute of Animal Nutrition at the University of Adelaide, where he was appointed professor of biochemistry and general physiology. Returning to England after three years, he was still active in many scientific fields. While living in retirement at Cambridge he carried out a fundamental research on myxomatosis of rabbits and its immunological implications. In collaboration with colleagues at the Lister Institute in London, he took an active part in an experimental study of the nutritive value of maize, made on pigs at Cambridge, as a contribution to the solution of the pellagra problem in man. On the outbreak of the Second World War, he arranged accommodation at his house in Cambridge for the Nutrition Unit which was evacuated from the Lister Institute in London, and gave valued help to the various war problems which devolved on this team. The war over, Sir Charles was seventy-nine years of age; it was only then that the disabilities of old age began to tell upon him. Even so, in the following years he carried on with scientific work—his last paper was published in 1948—and was able to make useful

comment upon the work of those colleagues who came to see him, and to keep to the end his interest in scientific matters. He was chairman of the Committee of the Dunn Nutrition Laboratory in Cambridge until 1946 and scientific adviser to the International Wool Secretariat until 1949. He died on February 15, in his ninetieth year.

Martin's achievements lay in many different fields of scientific inquiry. In his early days in Australia, he was concerned with problems of the metabolism and the heat exchange of marsupials and the monotremes *Echidna* and *Ornithorhynchus* (duck-billed platypus), those half-mammals indigenous to that country. Added to this work were studies of the toxins and antitoxins of snake venom, in the course of which he developed an ingenious ultrafilter, thereby demonstrating the difference in their molecular sizes. While at the Lister Institute, his own researches included studies on the epidemiology of plague and the mechanism by which the infected rat flea is enabled to infect the human host, and the mechanics of the disinfection process and of the heat coagulation and precipitation of proteins. With himself as subject, he investigated the thermal exchange and heat regulation of the human body under varying conditions of environment and physical work. His lectures on this subject were delivered as the Croonian Lectures of the Royal College of Physicians in 1930. He took an early interest in the modern study of nutrition, and from 1910 onwards work was in train at the Institute on the cause of beriberi and the distribution among foods of the preventive vitamin. A prepared mind thus enabled him, in 1915, to recognize, as a form of beriberi, a disorder among the Australian troops in the Middle East which had baffled the Army clinicians, and to recommend measures for its prevention and cure. After the end of the First World War he became interested in the biological value of food proteins and, again on his own person, carried out experiments which are acknowledged as a model for tests of this type.

In addition, he was an inspiration to his colleagues who dealt so successfully with the problems of fermentation, calcification of bone, the chemistry and metabolism of fat, plague, immunology, bacteriology and nutrition. Though he was not trained in all the necessary techniques, he was widely read, had an excellent memory and could contribute usefully to work in many varied fields. He was able to see the essence of a problem and to sense the lines upon which its solution might be possible. This, coupled with his ability to make apparatus that would do the job both for himself and for others, made him so valuable in the early days in Australia where equipment was lacking, and at the Lister when by far the quickest way to get apparatus was to make it oneself.

Although Martin left Australia when he was thirty-seven years of age, he never lost his contact with that country, a contact enlivened by the constant stream of Australian graduates who came to the Lister Institute. There they found a spirit of intellectual adventure which was kept in proper bounds by severe criticism, hatred of slipshod work, great integrity and dislike of self-advancement. Australia never ceased to appreciate what he had done, and in 1953 the Australian Government funded two medical research fellowships in his name to enable young Australian scientists to work overseas.

Sir Charles Martin received the Royal Medal of the Royal Society in 1923. He was a doctor of science of the Universities of London and Melbourne and held honorary doctorates of the Universities of Sheffield, Edinburgh, Durham and Trinity College, Dublin, and was an honorary M.A. of Cambridge. He was knighted in 1927. In 1926 he was made a member of the Medical Research Council, and he gave valuable help on many government committees.

Sir Charles Martin married Edythe, daughter of Alfred Cross, of Hastings, and had one daughter. His wife died in March 1954, at the age of ninety-four years.

HARRIETTE CHICK
ALAN N. DRURY

It was in his capacity as chairman during 1934-46 of the Committee of the Dunn Nutritional Laboratory, Cambridge, that I had the privilege of getting to know Sir Charles Martin well, and so of coming to respect, to admire and to love him. Intellectually, what stood out most was his astonishing width of interest and knowledge, in the most varied fields of medical research. Equally at home in many specialized departments of pathology, physiology, bacteriology, or biochemistry, he had the gift of seeing right into the heart of a problem; and knowing, as he did, how the present knowledge had been won, he quickly sensed what gaps still remained to be filled in. He was interested in knowledge for its own sake, and, unlike some lesser men, judged a research finding on its merits alone, not by its authorship. In consequence, he was able to recognize talent and originality where others might miss seeing it, and, as a result, had the satisfaction of fostering young, and sometimes precarious, research careers—leading in one instance at least to a later Nobel laureateship. He was never one of those prone to put his own name on the title of the papers of his assistants and students, published from his institute. On the contrary, it was an open secret that, during the years that he was director of the Lister Institute, much of the now classical work appearing under other names was really suggested, inspired and directed—sometimes even down to the smallest technical details—by him. He himself took a pride in being a competent technician and handyman, and in "Who's Who" gave "tinkering" as his hobby. Entirely devoid of affectation and pretentiousness, he had not the inclination to waste time, for example, on the elegancies of dress, and on more than one occasion had—but only for a moment—been mistaken for a wandering tramp.

Martin's scientific integrity was marked by a robust sense of right and wrong, and fair dealing, combined with practical common sense. He was prepared, in no uncertain voice, when occasion demanded, to stand up against established authority. To his junior colleagues and to his friends, he could at times be blunt and outspoken to a degree; but his direct speech never caused resentment, and one was warmed by the friendly, welcoming smile, always lurking below. Although in his own tastes simple to a degree, he could prove himself a man of the world in dealing with officialdom; indeed, one of his maxims was that people who failed to rub shoulders with their contemporaries had not succeeded in learning one of the elementary 'techniques' of their trade. Another of his maxims was that it is useless to appeal to reason where a person's emotions have become involved.

Up to the end, Sir Charles retained both his charm and penetrating intellectual faculty.

LESLIE J. HARRIS

Dr. W. W. Barkas

WILFRID WATSON BARKAS, reader in paper-making technology in the Faculty of Technology of the University of Manchester, died on January 30 at the age of fifty-seven. Dr. Barkas was a North-countryman who was educated at the Friends' School in Kendal and in the University of Manchester.

During the latter part of the First World War, Barkas served with the Friends' Relief Service in France and returned home with "a deep appreciation of the finest qualities of the French peasant" and "a love of French food and wine". After graduation in physics and mathematics in Manchester, he took a teacher's diploma; but he was glad that he did not become a teacher. Instead, he joined the staff of the Physics Department of University College, London. He never fully recovered from a serious illness he had at this time.

In 1930 he was appointed to organize the Timber Physics Department at the Forest Products Research Laboratory in Princes Risborough, where he proved a "generous and inspiring leader". While there he published a considerable amount of original work on the properties of fibres and fibre assemblages, for which he obtained his D.Sc. in 1945 and his fellowship of the Institute of Physics in 1946.

In 1949 he took charge of the Paper Making Section in the Manchester College of Technology, where he completely re-organized the courses. In doing this he was helped by his good personal relations with the leaders of the paper and board industry, who showed their support of him by the foundation of the George Rackley Scholarships to encourage students to take the new courses.

Barkas's research work greatly impressed foreign scientists. In 1948 he was invited to deliver a series of lectures at the Swedish Forest Products Research Laboratory. These lectures were very well received and Prof. Steenberg says of them that they have had "a very marked influence on the general way of thinking in Scandinavia". Last autumn there was a symposium at the Institute of Paper Chemistry in Appleton, Wisconsin, sponsored by the Research Councils of the Technical Association of the Pulp and Paper Industry of the United States and the Canadian Pulp and Paper Association and attended by two hundred of the leading workers in this field. As Dr. Barkas himself was not able to attend, the delegates to the symposium sent him a cable of appreciation of his work on which so much of their discussion had been based.

It is very sad that he did not live to see the full fruition of his ideas. He will be greatly missed by all who knew him.

J. M. PRESTON

Dr. C. W. Bellerby

CHARLES WILLIAM BELLERBY, who died on October 27 last year, will be remembered for several noteworthy contributions to reproductive endocrinology. He graduated in 1923 in Cambridge, as a member of Christ's College, and in 1925 joined me in the Department of Physiology in University College.

London, where we carried out a series of researches on ovarian extracts. Later he spent some time with Prof. J. (afterwards Sir Jack) Drummond in the Department of Biochemistry, and with Dr. F. H. A. Marshall in the School of Agriculture, Cambridge. During this period he made the observation that the castrous rabbit could be caused to ovulate by the administration of anterior pituitary extracts. In 1934

he was awarded a Beit Fellowship to work with Prof. L. T. Hogben at the London School of Economics and made valuable contributions to the study of *Xenopus laevis* as a laboratory animal and to its use for pregnancy diagnosis. During the Second World War he was concerned with civil defence and operational research, and afterwards with archaeological investigations. A. S. PARKES

NEWS and VIEWS

Sir Edward Bullard, F.R.S.

SIR EDWARD BULLARD's decision to resign from the directorship of the National Physical Laboratory and to accept a research fellowship at Gonville and Caius College, Cambridge, may have surprised those unfamiliar with his earlier career. Ever since 1934, when he became University demonstrator in the Department of Geodesy and Geophysics at Cambridge, his interests have centred around the earth sciences. Apart from the War years, he remained at Cambridge until 1948, during which time he not only made important contributions to these subjects himself but also stimulated others to study geophysics. As professor of physics at Toronto (1948-49) he built up a school which now trains nearly a quarter of all the geophysicists in North America. It is natural, therefore, that, after five years at the National Physical Laboratory, Bullard should wish to go back to Cambridge to devote himself to geophysics. His return will be welcomed by all those interested in the development of the earth sciences in Britain. The numbers of geophysicists trained each year in Great Britain is only about one-twentieth of the number in the United States and is inadequate to meet the rapidly growing needs throughout the Commonwealth. Bullard's return to Cambridge may well lead to an increase in teaching and research, and so help to raise both the quantity and quality of British geophysicists.

Geology at Cambridge :

Prof. W. B. R. King, O.B.E., F.R.S.

PROF. W. B. R. King retires from the Woodwardian chair of geology at Cambridge at the end of this academic session. As a graduate of Jesus College, a Fellow of Magdalene, a member of the Sedgwick Museum's teaching staff in the inter-war years, and professor since 1943, he has had a long association with Cambridge geology; but he has also held other appointments which have given him a great width of experience. In chronological order may be mentioned his period as a member of the Geological Survey, his service as an army geologist in France during the First World War, his tenure of the chair at University College, London, and his distinguished services for the army during and after the Second World War. At present he is completing his second year as president of the Geological Society of London. Prof. King's research work has had the variety which his career might suggest. It has ranged from the stratigraphy of the Lower Palaeozoics of Central Wales and Northern England to that of the Pleistocene of the Thames and East Anglia, and from the geomorphology of his native north-west Yorkshire to the hydrology of the Chalk. In recent years, working in close collaboration with the Admiralty and the geophysicists, he has become the recognized authority

on the geology of the English Channel. He retires full of vigour and with the leisure to increase his reputation as a research geologist.

Dr. O. M. B. Bulman, F.R.S.

DR. O. M. B. BULMAN, who will succeed Prof. King, is one of the best known of the students of Prof. W. W. Watts at the Imperial College of Science and Technology, London. He proceeded afterwards to Sidney Sussex College, Cambridge, to study for his Ph.D. degree, and, after a short break, returned to Cambridge as a member of the Sedgwick Museum. When Dr. Henry Woods retired, he became reader in palaeozoology, and it is from this position that he has been elected. Although Dr. Bulman's election breaks a long sequence of stratigraphers in the Woodwardian chair, he is no stranger to stratigraphical research, while the special side of palaeontology which he has made so much his own is the most-valued of tools in the stratigraphers' hands. It is, however, as a pure palaeontologist, and in particular as a student of the graptolites, that Dr. Bulman has established his world-wide reputation. He stands now as the rightful wearer of the mantle which Lapworth first assumed.

Meldola Medal, 1954

THE Meldola Medal is the gift of the Society of Maccabæans and, on the recommendation of the Council of the Royal Institute of Chemistry, is awarded each year to a British chemist less than thirty years of age on the strength of his or her published work. This year it has been awarded to Dr. J. S. Rowlinson, lecturer in chemistry in the University of Manchester. Dr. Rowlinson is a graduate of the University of Oxford, where he took his doctorate for research on some of the physical properties of organic vapours, particularly the dispersion of ultrasonic waves in gases. On going to Manchester in 1951 he extended his work on liquids to regular solutions and also studied the surprisingly high solubility of solids in compressed gases, which was shown to be due to forces in the gas-phase between single molecules of the solid and clusters of molecules of the gas. Dr. Rowlinson has recently been developing a perturbation treatment of the effect of molecular shape on the bulk properties of fluids, and is also doing experimental work on the properties of liquids and compressed gases, using highly polar substances, fluorine compounds and iodine solutions.

Iron and Steel Institute

THE following awards have been made by the Iron and Steel Institute. *Bessemer Medal* (1955), to Prof. John Chipman, head of the Department of Metallurgy, Massachusetts Institute of Technology, in recognition of his distinguished contributions to the knowledge

of the physical chemistry of steel-making; *Sir Robert Hadfield Medal* (1955), to Mr. Tor Fjalar Holmberg, of Oy Vuoksenniska A.B., in appreciation of his meritorious service in improving the technique of the production of iron and steel at the Inatna Works, Finland; *Andrew Carnegie Silver Medal* (1954), to Mr. B. Cina for his paper on the effect of cold work on the gamma-alpha transformation in some iron-nickel-chromium alloys (*J. Iron and Steel Inst.*, 177, 406; 1954); *Williams Prizes* (1954), of £100 each, to W. Jackson for his paper on the use of cold coke oven gas and pitch-cresosote firing in tilting furnaces (*J.*, 178, 378; 1954), R. McDonald for his paper on steelworks waste-heat boiler practice (*J.*, 176, 71; 1954), and A. Stirling for his paper on the pelletizing of Northampton sand ironstones by vacuum extrusion (*J.*, 177, 25; 1954).

Diploma of Fellowship of the City and Guilds of London Institute

THE Council of the City and Guilds of London Institute has conferred the diploma of fellowship upon the following past students of the City and Guilds College: Mr. A. McL. Mooney, deputy director of electrical engineering, Admiralty, a post in which he has been responsible for much special development work; Sir Ralph Reed, lately chairman of Albert E. Reed and Co., Ltd., paper manufacturers, who was paper controller for the Government during the Second World War; Dr. E. H. Rodd, formerly of the Dyestuffs Division, Imperial Chemical Industries, Ltd., whose work in the dyestuffs industry has been responsible for many advancements, both in fundamental knowledge and in industrial practice; Mr. N. E. Rowe, technical director of Blackburn and General Aircraft, Ltd., formerly of the Ministry of Aircraft Production, and now president-elect of the Royal Aeronautical Society; Mr. C. W. Speirs, formerly of the Morgan Crucible Co., Ltd., London, and a pioneer in the application of carbon in the electrical industry.

Training of Engineers

A NEW method of training boys leaving public and grammar schools to become professional engineers capable of filling responsible engineering, administrative and sales positions in industry has recently been introduced by the General Electric Co., Ltd. It is an industry-based 'sandwich scheme' operated by the Company in conjunction with the Birmingham College of Technology. In future all boys selected by the Company for this training will, on leaving school at the age of eighteen, be given a five-year course, in which full-time sessions of six months at the College of Technology will alternate with six-month periods of industrial training in the Company's works. At the end of the course a young man will have gained exemption from the professional requirements of a body such as the Institution of Electrical Engineers, and will, if he remains with the Company have as good prospects in the Company as the man who has spent three years at the university followed by two years as a graduate apprentice. During the whole of the five-year course, the Company not only pays a student's college fees but also gives him suitable remuneration to cover his living expenses. Two country houses in the Midlands are used by the Company as halls of residence. Boys on the course have their national service deferred until its completion. The college and industrial elements of the course are planned as a whole and are sufficiently

flexible to meet the needs of individual students. At the moment about sixty boys at the Birmingham College of Technology are Company student trainees on the first year of their course. In three years' time this number will have risen to between 250 and 300.

Queen Elizabeth House • Oxford Centre for Commonwealth Studies

A CHARTER has now been granted by H.M. the Queen to Queen Elizabeth House, Oxford, the new Oxford centre for Commonwealth studies, and in it the purpose of the foundation is defined as follows: to facilitate studies in political, economic, legal, administrative, social and cultural matters affecting the peoples of the British Commonwealth overseas and especially, but not exclusively, the peoples of the Colonies, Protectorates and other territories for which the Government in Britain is directly responsible; to provide a centre to which persons of authority or influence can resort for the study of such matters and the exchange of information; to assist such persons to obtain access to the academic resources of Oxford and elsewhere; and generally to act as a link between individuals and institutions concerned with these affairs. It will be noted that, when the project was first announced (see *Nature*, 174, 19; 1954), Queen Elizabeth House was to be a centre for Colonial studies, but that this has now been broadened to include Commonwealth studies generally, though the Colonial aspect is still the prime one. The Government has appointed Viscount Chandos as president of the governing body of Queen Elizabeth House, which will consist also of the vice-chancellor of the University of Oxford *ex officio*, four members appointed by the Government, four appointed by the University of Oxford and not more than eight appointed jointly by the Government and the University. The names of most of the members have been announced. Subject to confirmation, temporary quarters for the House have been secured in St. Giles, Oxford.

Abstracts of Instrument Techniques

THE one hundred and fourth issue of the *Bulletin of the British Scientific Instrument Research Association* (9, No. 11; November 1954) contains the twenty-thousandth abstract, compiled by the Association, of literature about scientific instruments published during the past nine and a half years, and gives an indication of the growth in importance of the science of instrumentation. The index to Vol. 8 (1953) of the *Bulletin*, which is now available, consists of an author and subject index to the 2,769 abstracts published during 1953 and covers some three hundred pages. Members of the Association and non-member organizations and individuals engaged in branches of industry or research where it is important to keep abreast of new developments in instruments, techniques and methods of measurement will find the *Bulletin* most valuable for handy reference and as an informative guide to the literature.

Meeting in New Mexico on Problems of Arid Lands

THE American Association for the Advancement of Science is arranging an international meeting on "Arid Lands", to be held in New Mexico during April 26-May 4. The programme will consist of a symposium, on "What is the Future of Arid Lands?", during April 26-29 in the University of New Mexico, Albuquerque, at which there will be a discussion.

meeting on the final day preceded by four technical sessions as follows: variability and predictability of water supply in arid regions; better use of present resources; prospects for additional water sources; and the better adaptation of plants and animals to arid conditions. Following this there will be a two-day field trip, and then a conference will be held during May 2-4 at the New Mexico Institute of Mining and Technology, Socorro, New Mexico. At this conference a specially invited group of experts, including members of the Unesco Advisory Committee on Arid Zone Research, will discuss the points raised at the symposium and try to formulate some definite recommendations for research and development programmes in the near future. Further information can be obtained from the American Association at 1515 Massachusetts Avenue, N.W., Washington 5, D.C.

University of London

PROF. H. R. ROBINSON, emeritus professor of physics in Queen Mary College, London, has been re-elected vice-chancellor of the University of London for the academic year 1955-56.

The following appointments have been made in the University of London: Dr. D. W. G. Style, reader in chemistry in King's College, to the University chair of chemistry tenable at that College; Dr. H. F. Cook, senior lecturer in the Middlesex Hospital Medical School, to the University readership in physics tenable at that School; and Mr. S. S. Frere, lecturer in archaeology in the University of Manchester, to the University readership in the archaeology of the Roman provinces tenable at the Institute of Archaeology.

The Queen's University of Belfast

THE following appointments have recently been made: Prof. P. L. Burns, professor of electrical engineering; Prof. T. P. Allen, professor of light electrical engineering; Prof. F. V. Warnock, professor of mechanical engineering. Prof. Burns and Prof. Warnock were formerly professors, and Mr. Allen lecturer, in the Belfast Municipal College of Technology.

The following lecturers have been appointed: N. R. Knowles and J. G. Murray (agricultural bacteriology); J. Lowe, R. H. Stewart and Mrs. H. Dales (agricultural botany); J. S. V. McAllister and Dr. W. O. Brown (agricultural chemistry); R. J. Willis (agricultural zoology); E. L. Calvert (mycology and plant pathology); Dr. D. Luke and Dr. J. K. L. Pearson (veterinary science).

The University announces the following grants: 16,500 dollars from the Rockefeller Foundation to be used mainly to purchase an infra-red spectrophotometer for the Department of Chemistry; £800 from the British Petroleum Co., Ltd., to provide a research fellowship in physical and inorganic chemistry; £500 from the Shell Oil Co., Ltd., to be used for research purposes in chemistry.

Announcements

SIR HAROLD SPENCER JONES, Astronomer Royal, and Prof. S. A. Waksman, professor of microbiology in Rutgers University, New Brunswick, have been elected foreign associates of the Paris Academy of Sciences.

MR. H. N. RIDLEY has been awarded the Colwyn Medal of the Institution of the Rubber Industry and

also elected to honorary fellowship of the Institution in recognition of his outstanding services to the rubber industry. Mr. Ridley was the pioneer in the tapping of the rubber tree, and his hundredth birthday falls later this year. The Institution is devoting an issue of its *Proceedings* to an appreciation of his work and to tributes to his high achievements.

MR. A. HOLROED, sewage works manager, Wolverhampton, has been appointed a member of the Water Pollution Research Board of the Department of Scientific and Industrial Research, in succession to Dr. F. S. Jenkins, who has completed his term of office.

THE Arnold Gerstenberg Studentship for 1956 is open to students in the University of Cambridge who, going into residence not earlier than 1950, have obtained honours in the Natural Sciences Tripos and who wish to pursue a course of philosophical study. The Studentship will be awarded for an essay which must be submitted before May 1, 1956. Further details can be obtained from Prof. R. B. Braithwaite, King's College, Cambridge.

THE tenth annual exhibition organized by the Northern Division of the Institution of Electronics will be held in the College of Technology, Sackville Street, Manchester 1, during July 14-20 (10 a.m.-10 p.m.; except July 14, 2-10 p.m., and July 16, 10 a.m.-6 p.m.). The exhibition will consist of a manufacturers' section and a scientific and industrial research section, as well as lectures and film shows. Programmes of the lectures and film shows (4d.) and catalogues (2s.) will be available later. Admission tickets, free of charge, can be obtained from the honorary exhibition organizing secretary, Mr. W. Birtwistle, 78 Shaw Road, Rochdale, Lancs, or from any of the exhibitors.

A ONE-DAY conference on "The Film in Chemical Engineering", organized by the British Universities Film Council, in co-operation with the Shell Film Unit and Prof. G. F. Mucklow, of the Department of Mechanical Engineering, Birmingham, will be held in the University of Birmingham on April 5. Prof. F. H. Garner, of the Department of Chemical Engineering, Birmingham, and Mr. E. le Q. Herbert, of the Shell Film Unit, will be the principal speakers. The conference will be open to all. Further information can be obtained from Dr. J. Horne, University, Birmingham 15.

A SYMPOSIUM on "Sound and Vibration in Solids", organized by the Fachausschuss Akustik der Deutschen Physikalischen Gesellschaften in collaboration with the Fachgruppe Schwingungstechnik im Verein Deutscher Ingenieure will be held in the Mathematical Institute of the University of Göttingen during April 19-22. Twenty-five papers will be read by German workers, and the rest will be as follows: British and Italian, three each; Belgian, French and Swiss, one each. During the symposium there will be a small exhibition of industrial measuring apparatus for structure-borne sound. The fee for the symposium is D.M. 15. Further information can be obtained from "Körperschalltagung", Göttingen, Bürgerstrasse 42.

IN a note in *Nature* of March 5, p. 412, it was stated that the principal contributions to a symposium on "Mechanisms of Microbial Pathogenicity" during the annual meeting of the Society for General Microbiology will be available in book form. This is being published by the Cambridge University Press, from which non-members of the Society can obtain copies (price 25s.).

BEHAVIOUR OF THE LIVING CELL

THE papers presented at a conference on "Tissue Culture in Pharmacology" held by the Section of Biology of the New York Academy of Sciences, and the Tissue Culture Association, Duke University, during January 14-16, 1954, have now been published (*Ann. New York Acad. Sci.*, 58 (7), 971-1326; 1954). They are concerned with the behaviour of the living cell as a whole, and contain many excellent high-power photomicrographs of living cytoplasm. Parts taken from ciné films show the motion of the various elements in the cytoplasm which is so striking a feature of living cells, not only in tissue culture but also in the whole animal, as the window technique of Algire recently demonstrated. It provides a refreshing and welcome balance in the field of cytology, which has tended to become overloaded with studies on dead cells and particularly with observations exclusively on the nucleus.

A great deal of cytology in the past has been done using fixation methods which dissolve away the cytoplasm so as to render the nucleus more accessible to observation. Since a large part of scientific thought is unconscious—and especially creative thought based on processes of which we are not aware—and since effective intuitive ideas can only be based on past experience (which may be forgotten), the process of looking at cells which have been deprived of their cytoplasm by fixation year after year would tend to create the feeling or intuition that 'there is no cytoplasm'. This is very evident in the writings of some who have subjected themselves to this activity. The papers in this collection help to remind us that cytoplasm plays a striking part in the activities of cells.

For some, the development of tissue culture over the past fifty years has been somewhat of a disappointment. The early promise in the days of Harrison and Carrel led one to expect that many fascinating experiments on living cells would be carried out. These did not appear to any large extent (with some important exceptions), and it was as if the success in getting cells to grow at all was the occasion of so much joy that progress became fixed at that point. The present series of papers represents a departure from this, and one is entertained by some of the advances in the past few years in which the cultured cell is used as a tool for discovering the answers to questions which one has been wanting to know.

Important advances in culture technique are described by W. R. Earle, G. O. Gey and their colleagues. By a systematic study of the effect of various supporting surfaces for the cells, and of agitating the medium, Earle has succeeded in regularly growing a mass of cells of the order of 1 gm. in weight from each inoculation, and, if necessary (after conditioning the medium), from a single cell. This should have repercussions in several directions, especially in biochemistry, where the use of homogeneous populations of tissue cells, instead of mixtures as heretofore, to compare cell with cell should initiate a new biochemistry of the tissue cell and, especially, a biochemistry of cancer.

The development of completely liquid media by Gey and by Earle enables cell suspensions to be handled like solutions, and measured out in aliquots, thus eliminating some of the biological variation in

the testing of drugs. These liquid media also enable growth to be measured by the counting of nuclei instead of by the erstwhile indirect method of nucleic acid determination.

It is pleasing to note that the culture of cells appears to have been stripped of much of the semi-mystic ritual of Carrel and placed on a fairly scientific basis. There seems no reason why these advances in technique should not have been made thirty years ago, except perhaps a paralysing belief in the need for following a prescribed ritual.

C. M. Pomerat has measured the toxic concentrations of 110 substances on chick and human cultured cells. In view of the known wide differences in susceptibility of various mammalian species to the same drugs, and particularly to carcinogens, and the paucity of information on human material, this method should fill a gap in knowledge without the use of human volunteers and with less variation than with the use of individuals.

The use of tissue culture in the rapid screening of anti-cancer substances is reported in several papers. Here again, the importance of being able to cultivate any kind of tissue cell is emphasized. It is not yet known whether this is possible, and perhaps all the problems are not yet solved. But a favourable therapeutic index obtained on comparing the response to a drug of neoplastic cells with that of fibroblasts has sometimes given disappointing results when the drug is tested in the whole animal, where the more susceptible (but less easily cultured) intestinal epithelium and bone marrow are usually injured. As pointed out in the discussion, it would be better to use these two tissues as controls in culture.

J. T. Syverton and W. F. Scherer describe the use of cultured mammalian cells for the assay of viruses and their antibodies. Here again one notes the use of the more readily proliferating tumour cells as indicator, rather than normal cells, though the results appear to be satisfactory.

Several interesting papers describe the effects of various substances on the cytoplasm of cultured cells. While no explanations are yet forthcoming for these effects in terms of chemistry and physics, it is to be hoped that, by supplementing the observations on the more easily handled Protozoa, the comparison should bear fruit.

Pomerat and Gey re-focus attention on the important phenomenon of 'pinocytosis' whereby proteins may enter living cells. This has been almost entirely neglected since first described by W. H. Lewis in 1931. W. R. Duryee and J. K. Doherty, and also Pomerat, describe the excretion of visible material from the nucleus into the cytoplasm. The former put forward an interesting theory of mitosis.

While it is not possible to mention all the remarkable findings reported in this conference, many of the contributors seem to be conscious of the effectiveness of their approach and of the impact which it is making on the field: "Gone for ever . . . is the notion of the fixed rigidity of cells". "What greater contribution could there be to the study of the mechanism of drug action than to pinpoint with precision the part of a cell that may become altered by the drug? This qualitative approach . . . is more fruitful than the knowledge, for example, that

50 per cent of a population of cells is destroyed by a given concentration of a drug", to quote a few of the enthusiasts.

It is not the function of this survey to direct attention to misprints and the like; but the statement on p. 1224 that DNA is the chief chemical component of enzymes seems remarkable.

This report can be thoroughly recommended to biologists and pharmacologists as providing stimulating reading: so much so that it ends with a poem expressing the excitement one may feel at beholding Pomerat's ciné films.

R. J. GOLDCRE

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS

MEETING AT THE HAGUE

THE seventh meeting of the European Association of Exploration Geophysicists was held at The Hague during December 8-10, 1954, this being the first occasion when an earlier venue had been revisited. In the three years since the inaugural meeting there, the membership has grown from its anticipated strength of about one hundred and fifty to a present strength of more than eight hundred—an indication of the very active European interest in exploration geophysics. With the president, J. Goguel, in the chair, the proceedings began with a short business meeting and an opening address by Prof. Vening Meinesz. The technical meeting included the presentation of twenty-two papers, nine dealing with seismic, seven with gravity, three with electrical and three with magnetic methods. This distribution does not fully correspond with that of exploration effort between the various methods which, in terms of numbers of field parties, has been quoted recently by Germain-Jones¹ as seismic 50, gravity 18, electrical 24 and magnetic 8 per cent, out of a total of some two hundred and thirty parties based on Europe.

Four of the seismic papers described theoretical approaches to field problems, the first by Y. d'Erceville (France), dealing with the velocity of propagation of longitudinal waves in muds. The observed velocity in such materials is often lower than that of either the solid or liquid constituent, and using a simple mathematical model he showed that such a velocity might be expected. Unfortunately, the theory also predicts a velocity, intermediate between those of the constituents, which is not observed in practice, and there was some criticism of the completeness of the chosen model. A. Stein (Germany), in attempting to determine the applicability of the reflexion method to mining problems in Siegerland, had calculated the energies to be expected in longitudinal and transverse waves reflected from siderite veins of various thicknesses. In a more purely theoretical approach to a similar problem, J. Baumgarte, H. Menzel and O. Rosenbach (Germany) dealt with the reflexion of longitudinal waves at a thin layer lying between media of differing velocities. The frequency spectrum and the energy/time relationships were discussed both for sinusoidal plane waves and for an incident pulse of arbitrarily chosen form. Although necessarily somewhat limited by the initial assumptions, this was felt to be a very promising step in the investigation of changes of seismic pulse wave-forms. In a further paper on reflexion sur-

veying, W. Brauch (Germany) considered the travel-time curves with particular reference to the possibility of determining velocity distribution.

Three papers were concerned with the more practical aspects of seismic surveying. W. M. Jones and A. T. Dennison (Great Britain) described a portable geophone, designed for long-distance refraction surveys, which has a natural frequency of 2 c/s.; while there is some doubt whether this low frequency is required, experimental evidence on the subject is indecisive. The discussion on a protractor, designed by J. Schoeffler and E. Diemer (Germany) to facilitate the computation of refraction results, showed that many computers devise such instruments for the solution of their most frequent problems; apart from those described at the meeting, instruments of similar type though differing in detail have been described elsewhere². For several years, multiple geophone groupings have been used in reflexion surveying to minimize the background noise due to the shot, and H. Richard and M. Rimbaut (France) gave the results of a quantitative field study of the improvement obtained with various linear arrays; this was found to depend, approximately, on the square root of the number of geophones.

A. M. Selem (Italy) gave a comprehensive description of the instrumental and interpretative techniques required for a reflexion survey in a coastal region of Southern Abruzzi, an area characterized by a heavily eroded topography. The use of special vehicles and field techniques has enabled the survey to be mainly truck-borne in spite of the steep gradients encountered. Variations in the near-surface layers and the rapid changes of surface elevation required a detailed investigation of the requisite corrections; although the results have not yet been checked by drilling, it is thought that the techniques applied have been very successful. At the present stage of geophysical prospecting, it is somewhat unusual to hear a new method proposed. In this case, M. Matschinski (France) suggested that measurements of the seismic ground unrest could yield information on the underlying geological structure. Assuming that the seismic background is random in nature, he has applied statistical methods to show that measurements of shear strain and of the particle velocity at the surface are related to the depth and character of the geological formations. While certain instrumental and field problems can be envisaged in the practical application of such a method, it remains an interesting suggestion for the practical use of what are otherwise, like telluric currents in electrical prospecting, merely unwanted background noise.

In the gravity section, three authors were concerned with improved techniques of interpretation. G. C. Colley (Great Britain) discussed the variations in elevation correction factor required to correct readings to the datum level, with special reference to its variation across geological boundaries and structures. Formulae were given for the case of dipping beds together with a general discussion of the anomalous effects which may result over anticlines and near outcrops, although it was agreed that application of the results would require some prior knowledge of the general geological picture. F. Sumi (Yugoslavia) was concerned primarily with a rather different application, the determination of the depth of an ore-body when its shape may be assumed. K. Jung (Germany) has derived a formula, suitable for numerical computations, for the topographical correction of gravity measurements; this is analogous

to the earlier formula, derived by Schwedjar, for the correction of torsion balance readings.

W. Domzalski (Great Britain) reported a series of gravity measurements made in underground workings, readings being obtained also at points on the surface vertically above those below ground-level. By averaging the rock density values measured in the laboratory, he has obtained good agreement with those calculated from the gravity measurements using the standard value for the mean earth density. A more academic note was struck by S. K. Runcorn (Great Britain), who discussed the recent investigations in Great Britain of the direction of magnetization of rocks, with special reference to sedimentary rocks. Their relevance to theories of continental movements was described, and he emphasized the importance of further measurements to give positive evidence on polar drift and on the relative movements of land masses.

The growing use of geophysical methods in mining operations was typified by a description of a gravity survey in east Carmarthenshire by J. T. Whetton, J. O. Myers and I. J. Watson (Great Britain). This detailed survey around a new colliery site, in an area of complex geological structure, has indicated the presence of various faults as well as anticlinal and synclinal structures. These results should help in the planning of the mine workings, and it will be interesting to see how closely the present geophysical interpretation agrees with the true geological picture. In a second report on a survey in northern Italy, C. Monnet (Italy) dealt with the extended application of the vertical gravity-gradient method. This has been used with excellent results over the areas of interest, and its use as a quantitative interpretation tool in other similar areas was recommended.

An interesting example of international co-operation was afforded by maps, presented by J. W. de Bryun (Holland), showing the Bouguer and isostatic isogals over most of Europe and North Africa. These maps are on a 1:5,000,000 scale with 5- and 25-milligal intervals, and the Bouguer map clearly illustrates the principle of isostasy. The isostatic isogals, based on the Airy-Heiskanen system, show predominantly positive anomalies, and the features of this map were discussed in some detail. A later edition of these maps will be prepared to include a considerable amount of data received recently, and any further information which may become available will be most welcome. H. Closs (Germany) has prepared, in a similar way, a map showing the magnetic Z-anomalies over Europe. He hoped to make further progress with this, although there were difficulties in combining the results of different field surveys owing to the lack of a common standard of measurement; in the discussion, some doubts were cast on the practical value of such a map. An analogous seismic-velocity map was suggested; but this would clearly require agreement on the aim of such a map and the choice of one of the various possible types of information to be shown.

A paper by V. Baranov (France) provided three charts to help in the interpretation of magnetic surveys. Plotting the observed results and visual fitting to the normalized values on the charts give a rapid interpretation of the observed anomaly. As an example of the use of the charts, he described a mining survey in the Pyrenees where one ore-body, and possibly a second, had been successfully located. The various geophysical well-logging techniques are in widespread use, and J. L. Mathieu and C. Rosoff

(France) gave a general account of the methods currently employed, though omitting the continuous velocity logger now available in America, but not as yet in Europe. They described how the original electrical methods, though successful in soft formations, had proved unsatisfactory in hard sandstones and limestones, and they showed how the methods developed since the Second World War had considerably improved the value of well logging in such hard formations. For surface electrical resistivity measurements, O. Koefoed (Holland) proposed a modified method of calculating standard interpretation curves and gave a set of such curves for a three-layer problem. He critically reviewed Hummel's method of interpretation and suggested an amendment to extend its useful range.

Finally, in a paper particularly appropriate to a meeting at The Hague, A. Volker and E. O. Houtsma (Holland) described resistivity measurements made in and near the Zuider Zee to determine the salinity of the subsoil. For the measurements in open water, a special cable had been used which provided nine different electrode combinations for each position on the sea-bed, with a consequent increase in the speed of working. The results are of importance both for agriculture and for the provision of water supplies, a further example of the widespread applications of geophysical surveys.

A. T. DENNISON.

¹ Germain-Jones, D. T., *Geophys. Prospecting*, 2, 177 (1954).

² Vajk, R., *Geophys.*, 19, 237 (1954).

THEORY OF PLASTICITY

THE James Clayton Lecture for 1955 of the Institution of Mechanical Engineers was given by Dr. William Prager, who chose as his subject "The Theory of Plasticity: a Survey of Recent Achievements", and Dr. Prager gives an account, both authoritative and entertaining, of the present position of the plastic theory. After a brief historical review, he states carefully the reasons for adopting simplified mathematical models, and emphasizes that the solutions derived therefrom can only be approximations to the physical truth. He then illustrates the stress-strain relations corresponding to the various simplified theories by reference to the displacements of cleverly devised kinematic models. These models are certainly most helpful as means of conveying a clear conception of the discontinuous stress-strain relations characteristic of the plastic state. Dr. Prager uses them for showing the difference between stress-strain theories based on total and incremental strain, a discussion which reveals clearly the conceptual superiority of the incremental laws.

The application of general plastic theorems in the calculation of ultimate load-carrying capacities in the fields of structural and mechanical engineering is then discussed. Methods of obtaining lower and upper bounds on collapse loads are introduced by reference to a simple structural example, in which plasticity takes the form of deforming hinges in a member subjected to a transverse load. The extension of these methods to continuous bodies, with application to mechanical engineering problems, is then described, and a number of illustrations are given. It is found that, while it is comparatively easy to obtain upper bounds in plane and three-dimensional problems, lower bounds are much more difficult to

realize. Recent advances in the derivation of exact values for critical loads are discussed.

The application of plasticity theory to steady-flow problems in which large plastic deformations occur, although stress and velocity fields do not change with time, is illustrated by reference to the plane problem of sheet extrusion. Another class of problem involving large plastic deformations arises when the shape of the plastically deforming part of a body remains constant, while the size increases as more and more of the originally rigid material becomes plastic. The lecture ends with a short section dealing with dynamic problems, and quotes as an example the case of a beam subjected to a transverse uniformly distributed blast load. The energy given to the beam and stored momentarily as kinetic energy is dissipated in deformation at plastic hinges, which may move progressively along the beam, thus producing plastic deformation over considerable lengths.

Dr. Prager's lecture certainly reveals a remarkable advance in the development of the theory of plasticity in recent years. The large part played by mathematical intuition in the derivation of many of the solutions is evident, and the many cases in which this intuition is successful in achieving solutions to practical problems represent the most stimulating feature of the theory of plasticity for the engineer. As progress continues, the place of intuition declines and systematic analysis takes its place. This survey has been made at a time when the second stage is well under way in many branches of the theory—a period full of danger as well as promise. The danger is that mathematical models found successful for certain problems may be applied indiscriminately under conditions where they become quite inadequate. This is revealed most clearly at the end of the lecture in the section dealing with dynamic loading, where a factor of over-riding importance, namely, the effect of rate of strain on the stresses producing the deformation, is scarcely mentioned. The lecture is concerned with the theory of plasticity, of which it is a most outstanding and opportune summary. It is for the engineer who applies the theories to satisfy himself that the mathematical model on which the theory is based is appropriate to his problem, either by fundamental investigations or by carrying out suitable tests under practical conditions. M. R. HORNE

CARNEGIE INSTITUTION OF WASHINGTON REPORT FOR 1953-54

R 305

THE report of the president of the Carnegie Institution of Washington, Dr. Vannevar Bush, for the year ended June 30, 1954*, explains in some detail the features of the new retirement plan which came into operation on July 1, 1954. He discusses the principles on which it is based, notably the importance of reaching understanding with those affected at the outset, and securing individual assent in advance to whatever changes or modifications are seen from time to time to be desirable to serve the best interests of the group concerned and provide a balanced provision against the risks which savings inevitably face. Of the research activities of the Institution,

* Carnegie Institution of Washington. Report of the President for the Year ending June 30, 1954. Pp. 15. (Washington, D.C.: Carnegie Institution of Washington, 1954.)

Dr. Bush notes that fully half the observing time of the 60-in., 100-in. and 200-in. telescopes at the Mount Wilson and Palomar Observatories continues to be devoted to spectroscopic and photometric studies of individual stars. Preliminary results of the spectroscopic investigations of globular cluster stars during the past two years indicate a lower excitation temperature for a given spectral class, and a substantially lower abundance of the metals than is found in population I, while photometric studies have revealed large differences between the two populations in the relation between total luminosity and surface temperature. In co-operation with the National Bureau of Standards, the United States Naval Observatory and the California Institute of Technology, the Institution is examining whether electronic image-conversion techniques offer a means of extending the range of large telescopes or increasing the utility of those of moderate size.

The Department of Terrestrial Magnetism reports considerable progress in our understanding of the structure of the atomic nuclei, based on the observation that most nuclei from fluorine to uranium can be made to radiate characteristic gamma-ray lines when bombarded by relatively low-speed helium ions from an electrostatic generator. About a hundred and fifty energy-states have been detected in some seventy nuclei examined at the Department by this 'Coulomb excitation' process. Experimental observations at the Geophysical Laboratory are gradually providing a quantitative basis for understanding the various assemblages of minerals found in the metamorphic rocks and have led to the synthesis of many minerals found in such rocks, including a series of micas and garnets, the ranges of stability of which as functions of temperature and pressure have been determined. Other studies have demonstrated that the recurrence of proteins in hard parts of recent creatures is widespread and that under favourable conditions fossils may contain amino-acids such as alanine, glycine, valine, leucine, aspartic acid and glutamic acid after 360 million years.

In the Department of Plant Biology, spectral changes of unidentified substances have been found in illuminated *Chlorella* suspensions. The work on grass this year has shown that environment may greatly influence the percentage of aberrant or 'off-type' plants that may appear in a stabilized, asexually reproduced strain. Under conditions of intense competition in unfavourable environments, the percentage of sexually produced variants may increase greatly in relation to the normally predominant asexual plants. The absolute absorption spectra of purified chlorophylls *c* and *d* and of bacteriochlorophyll have been determined, thus providing a means of determining these pigments in plants which use them for photosynthesis. Studies of forests on both sides of the Pacific suggest that the coast redwood was not a tree of the coast during much of its hundred-million-year history, but lived at higher elevations in the interior of North America.

Experiments on *Salmonella typhimurium* in the Department of Genetics indicate that a gene locus occupies a longitudinal section of the chromosome, and that changes occurring in different parts of the locus give rise to different new forms of the gene, that is, alleles. Recent work on the genetic mechanism of bacterial viruses indicates that viral nucleic acid controls viral inheritance, while studies of cell chemistry have focused attention on the importance of the nucleoprotein complex in vital cellular activity.

ties. Notable progress has been made in the Department of Embryology in the analysis of the control of sex differentiation in the embryo by the action of sex-gland hormones; and a long-term study of the blood flow through the placenta, first in monkeys bred for the purpose, and afterwards on human placentas, points to physiological factors—that is to say, differences in blood pressure between the maternal arterial and venous blood and the blood within the placenta—as the chief directive agency of the maternal placental circulation, assisted by anatomical features of placental structure. Experiments on pregnant rhesus monkeys suggest that sugar metabolism in the primate placenta is not like that in sheep, at least with respect to glucose and fructose. The Department of Archaeology continued its researches dealing with the prequest history of Yucatan.

RELATIONSHIP OF SCIENCE AND RELIGION

IN his Rede Lecture for 1954 on "Science and Religion: a Changing Relationship", which has now been published*, Prof. C. A. Coulson, pointing out that Nature (by which he means the totality of our environment) and man are central both to science and religion, maintains that the division of our experiences into those labelled scientific and those labelled religious is wholly unsatisfactory and false to the true character both of science and religion. Science claims to give an account of all our environment, and he believes that the limits of science are only those which are presented by the words: if a question about Nature can be posed in scientific terms, then ultimately it will be susceptible of a scientific answer. In remarking that every scientific law is a new imaginative conception, Prof. Coulson suggests that, like the artist, the poet and the saint, the scientist is making sense out of that part of his experience which appears most amenable to his own selective understanding; he is looking for a pattern within them which will satisfy him as reasonable and consistent. Science is one kind of pattern, art is another.

Our loss of immediacy in our relation to Nature has, Prof. Coulson thinks, increased rather than diminished the contrast between conventional science and religion. Among the scientists of to-day there are respect and excitement, sometimes astonishment, but all too seldom reverence; and if we could recognize that man's total response to Nature must include not merely the making of a pattern that may be called true but also the recognition that God is mediated to him both in the experience and in the pattern, science would be recognized as one of the languages in which God is revealed, and the work of scientists would be seen as part of God's work. The sense of immediacy, which has largely been lost in modern scientific study, would be rediscovered. Our approach to the study of man is also changing, and here Prof. Coulson thinks science can help religion by forcing us to see and understand the sacramental value of Nature and the wholeness and unity of things. Science is also a powerful and insistent reminder of the worth of reason at a time when men's faith in the virtues of reason is wavering. A

faith in rationality is central to the Christian tradition at its finest. Science is also affecting our view of the role of men within the whole pattern of Nature. Men and Nature are inextricably mixed, and Prof. Coulson believes that science has something to say about the very structure of human fulfilment, for which Christians have greater reasons for being grateful than they sometimes admit. There is a liberating quality about scientific thinking to-day, and yet a humility, which seems to him to augur well for a future complementary relation between science and religion.

In its methods of working, in its dependence upon the assumption of a spiritual wholeness about life, in its insistence upon the richness and variety of experience, and the inter-relatedness of all things within the role of a person, continued Prof. Coulson, the changing pattern of science has come back to something more like harmony with the Christian faith. In that new harmony there are new notes which would never have been sounded but for the patience, the integrity and the creative imagination of men of science. Lastly, all scientific beliefs are experimental in character, and the concepts of science acquire their validity only in experience. This is also true of the Christian faith, and it is one more debt which religion owes to science.

BURSTS OF RADIO EMISSION

R. D. DAVIES has published a paper entitled "An Analysis of Bursts of Solar Radio Emission and their Association with Solar and Terrestrial Phenomena" (*Mon. Not. Roy. Astro. Soc.*, 114, 1; 1954), which presents a detailed analysis of bursts of radio emission recorded at the Radiophysics Laboratory, Sydney, during January 1950–June 1951. This analysis includes a detailed study of the correlation of bursts with flares, sunspots, ionospheric fade-outs and magnetic crochets. While attempts to draw physical conclusions from the analysis have not been made in most cases, nevertheless certain results of immediate interest are briefly discussed. The radio data were obtained mostly from records at 200, 600, 1,200, 3,000 and 9,400 Mc./s., and in the latter part of the analysis these were extended to 62 and 98 Mc./s. All these came from the records taken at the Radiophysics Laboratory, Sydney, except the first, which came from records from the Commonwealth Observatory, Mt. Stromlo.

The analysis—in two parts—includes a number of histograms, and shows that many of the properties of bursts change with frequency (a burst is defined as "any clear-cut solar radio emission rising above the daily level"). A characteristic of bursts is their 'jaggedness', that is, short-duration rises and falls in intensity, and the degree of jaggedness decreases with increasing frequency. Tables, figures and histograms show that there are many interesting relations between the number of bursts and their frequencies, and also between bursts and sunspots, flares, fade-outs and crochets. As the frequency of bursts rises from 600 to 9,400 Mc./s., their average number per hour diminishes from 0.10 to 0.04, and the average interval between the bursts increases from 10 to 26 hr. A number of figures shows the distribution of the lifetime of the bursts at the different frequencies, the distribution of their decay times, the distribution of their intensities, etc.

* Science and Religion: a Changing Relationship. (Rede Lecture for 1954.) Pp. 36. By Prof. C. A. Coulson. (Cambridge: At the University Press, 1955.) 2s. 6d. net.

The second part of the analysis deals with the relation between radio data and sunspot data, and to do this an estimate was made of the average number of bursts per hour for each month; Fig. 7 gives a comparison of the three-month running means (number of bursts per hour) with the monthly average sunspot areas and numbers for the period referred to earlier. From this figure the following conclusions are drawn: (1) time plots of the burst index are similar at different frequencies; (2) there is a good correlation between the burst index and the sunspot area and number. Additional important results are the coincidences between flares and excess radio noise; at least 99 per cent of all flares are accompanied by excess radio emission in some part of the frequency-range, but it is admitted that this high correlation may be due to chance coincidences. So many other matters are dealt with that it is impossible to consider them all here. One further point, however, may be mentioned, namely, magnetic storms and world-wide crochets, briefly referred to in the appendix. On four occasions, listed in Table 6, the sudden commencement of a magnetic storm was preceded by a burst but not a flare, the time delay between burst and commencement of the magnetic storm varying between 20h. 58m. and 29h. 13m.; Table 7 lists eleven world-wide crochets, not accompanied by a reported flare, associated with bursts, between February and November 1950. These phenomena, it is stated, appear to be genuine and may be supposed to have a flare-like origin, judging from their association with bursts.

EARTHQUAKES DURING OCTOBER 1954—JANUARY 1955

DURING the last three months of 1954 there were in the world twenty-four earthquakes having instrumental magnitude 6 or greater. The greatest two had magnitude 7 and occurred on October 21 in the South Indian Ocean, and on December 16 near Fallon, Nevada. The latter caused moderate property damage. The earthquake of deepest focus during the period had a focal depth of 650 km. and occurred on November 25 in the Fiji Islands region. There were two minor British earthquakes. On the afternoon of October 23 South Elmsall (Yorkshire) was affected by a severe tremor which shook furniture and crockery. The shock was also felt at Hemsworth and Pontefract. On November 15 at 6.25 a.m. Winstar, in Derbyshire, was shaken by an earth tremor felt with Modified Mercalli intensity 4, which rattled crockery, pictures and furniture. The shock was also felt at Birchover and Elton. Both these earthquakes were accompanied by low rumbling sounds. Previous tremors at Winstar occurred in February 1952, and before that in 1903-4.

In other parts of Europe, earth tremors were reported to have occurred in October near Trieste, near Innsbruck and in Spain. On November 16 an earth tremor occurred forty miles south of Rome, and on November 23 at Grisi, near Palermo, in Sicily. The following month nearly all the houses on Salina Island (about fifty miles from Messina) were damaged in an earthquake swarm which began on December 23. Possibly associated with this, there was a lava flow accompanied by steam from the crater of Stromboli, while from Etna there issued a column of

smoke mixed with ash. Shocks and volcanic activity ceased by January 3. On December 23 an earthquake occurred in western Peloponnesus, injuring nineteen people and causing the collapse of several houses.

Elsewhere, on December 4 an earthquake with instrumental magnitude 6½ and depth of focus 60 km. occurred near Trinidad. One person was killed, several injured, and there was extensive property damage, including damage to Government House and both the Anglican and Roman Catholic Cathedrals. On December 21 an earthquake of instrumental magnitude 6½ occurred in Humboldt County, California, injuring several persons and causing extensive property damage.

During January of this year there were reports of eight earthquakes with magnitude 6 or greater. The greatest occurred on January 13 in the Fox Islands (Aleutian Islands). It was felt at Unalaska and had logarithmic magnitude 6.9. The shock with the greatest depth of focus occurred on January 22 in the Fiji Islands, its depth of focus being 650 km. The only shock reported as having caused property damage occurred on January 25 on the Tennessee-Arkansas-Missouri borders. The damage was of a minor character.

FORMATION AND CHARACTERISTICS OF LATERITE

THE dark-red, hard, barren, slag-like, acre-wide sheets of laterite commonly seen in the tropics have led many to conclude that this is the final wretched residue of soil-forming processes and represents the death of the soil. The origin of these impressive formations has long been disputed. Weathering has apparently been associated with removal of silica and bases; but that seems to be the case also with two other materials: Buchanan's laterite, a soft, vesicular, red earth which hardens on exposure and has long been used as building stones; and the deep, very friable, porous, dark-red, well-drained soils of forested slopes. Each of these materials consists largely of sesquioxides, and it has seemed remarkable that they differ so strikingly in their physical properties.

Dr. J. D'Hoore, director of the Service Pédologique Inter-africain and a distinguished member of the staff of the Institut National pour l'Étude Agronomique du Congo Belge, has thrown a welcome light on this problem by distinguishing 'absolute' and 'relative' accumulation of sesquioxides in soil*. He remarks that the concentration of a salt solution can be increased by adding salt (an absolute accumulation) or by removing solvent (a relative accumulation). Similarly, a low-lying area can receive an inflow of ferruginous solution, an absolute accumulation, and a high-lying area can suffer loss of silica and bases and thereby exhibit a relative accumulation of sesquioxides.

In the case of the low-lying area attention is given to the physical and chemical nature of the substrate (for example, mixed colluvial material) that receives the absolute accumulation of sesquioxides, and in the case of the upland area attention is given to the

* Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique No. 62: L'Accumulation des sesquioxides libérés dans les sols tropicaux. Par Dr. J. D'Hoore. Pp. 132. (Brussels: Institut National pour l'Étude Agronomique du Congo Belge, 1954.) 80 Belg. francs.

physical and chemical nature of the parent rock which undergoes a relative accumulation, this being another name for the process that leads to the formation of a sedentary soil of the Red Earth class.

Pripjat and Gastuche observed that an iron oxide sol if flocculated will form hard, coherent flakes; but if the flocculation is carried out in presence of clay under certain conditions, the iron is adsorbed on to the clay particles, and these remain loose and incoherent until their capacity for adsorption is exceeded. D'Hoore considers that in Nature also a similar process accounts for the more ready formation of hard crusts and hard concretions in a medium that is coarse and low in clay content.

In agreement with many other authorities, D'Hoore observes that a low-lying zone of absolute accumulation may be buried under new deposits or, if drainage improves and a cycle of erosion intervenes, may end up as the resistant capping of a flat-topped hill. These lateritic crusts (*cuirasses*) are liable to mechanical breakdown and to chemical dissolution, the latter being mainly due to formation of complexes with organic materials derived from growing plants. If the underlying material is well supplied with plant nutrients, fertile soils may result from the decomposition products of the lateritic crusts.

In considering the classification of these sesquioxidic accumulations, D'Hoore considers first whether

accumulation is in progress, whether it has stopped, or whether breakdown has begun. Within these major categories it is possible to recognize four modes of accumulation: *A*, absolute; *Ar*, the same with some relative enrichment; *R*, relative; and *Ra*, the same with some absolute enrichment. For an example of *Ar*, there is the low-lying accumulation on a substrate which is itself liable to removal of silica and bases. For an example of *Ra* we have the deep Red Earth in which plant roots bring into solution and mobilize a part of the abundant sesquioxides that are afterwards immobilized, forming a cement for particles that were previously loose. Further classification of the sesquioxidic accumulation proceeds on a logical plan, and illuminating accounts are given by Dr. D'Hoore of the visible characters of the various products and of the laboratory data, such as chemical analysis, differential thermal analysis and examination under the electron microscope, which can supplement field observation of morphology.

The publication is illustrated with well-chosen photographs and diagrams. It marks a memorable advance in our knowledge of some of the soil-forming processes which profoundly influence agricultural development in the tropics. In this field it will add to the already high prestige of the scientific work sponsored by the Institut National pour l'Étude Agronomique du Congo Belge.

ORIGIN OF THE VIRUS-PRODUCING CHROMATIC MASS OR NET OF THE INSECT NUCLEAR POLYHEDROSES

By N. XEROS

Plant Virus Research Unit (Agricultural Research Council), Moltano Institute, Cambridge

MANY authors, including Marzocchi¹ and Glaser², have maintained that the pathological intra-nuclear chromatic mass or network of the infected lepidopteran cell is a stage in the further development of a fused aggregation of nucleoli. This view, however, is certainly erroneous. Paillot³ and Heidenreich⁴ considered that the chromatic mass in a number of Lepidoptera is formed primarily by the fusion of chromatin granules of the pathological nucleus. (Paillot's and Heidenreich's further claim regarding the presence of supposed nucleolar remnants and their deposition on the chromatic masses is mistaken.) Bird⁵, in the case of a nuclear polyhedrosis in sawflies, and Xeros⁶, in a number of Lepidoptera, also ascribed its origin to the association of chromatin granules. Certainly there are appearances which suggest this interpretation. However, a more detailed examination of this aspect of the cytology of several nuclear polyhedroses failed to support it. It appears that the chromatic mass does not arise from any of the recognizable pre-formed bodies of the nucleus.

The nuclear polyhedroses investigated were those of the fat body and hypodermis of the Lepidoptera *Abraxas grossulariata*, *Lymantria dispar*, *Bombyx mori*, *Pyrausta nivalis* and *Panaxia dominula*; of the midgut of *A. grossulariata* and *B. mori*; and of the midgut of a sawfly, *Neodiprion sertifer*. In this work, Carnoy-fixed material was examined both with and without acid hydrolysis and ribonuclease extraction. Some deoxyribonuclease extraction was also

done. The most useful stains used were Giemsa, Schiff's reagent, toluidine blue and bromophenol blue. Some material fixed in formalin and osmic acid was also examined, as well as some live material. All the consecutive sections of many given nuclei at different stages of development of the disease were studied, and care was taken to ensure that the possibility of confusing nucleoli with the earliest stages of the chromatic net in material extracted with hydrochloric acid was avoided.

At about half-way through the infection cycle of the hypertrophied infected cell, there is a tendency for aggregates of nucleoli and chromatin granules to form. Some nucleoli fuse, others elongate, etc. About this time the chromatin granules, apart from those retreating to the nuclear membrane, either become closely associated with the surfaces of the nucleoli or remain loosely associated with the nucleolar clumps. At the same time the true chromatic masses make their appearance for the first time in the form of small patches, sheets or branching lobes of protein material which arise in between and peripherally to the nucleolar aggregates. The topographical relations at this stage, and for a long time after, may perhaps best be described as those of interdigitation or interlacement, the chromatic mass or masses in a nucleus interdigitating with the nucleolar masses.

The chromatic mass(es) as it grows, the nucleus itself meanwhile expanding, develops progressively

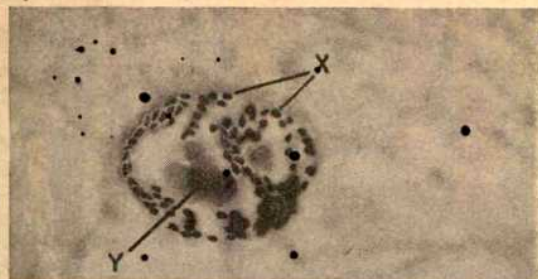


Fig. 1. Fat body cell of *Abraxas grossulariata*. X, discrete chromosome-nucleoli. Y, moderately developed chromatic net the pores of which at this stage are just resolvable by the light microscope. Photo retouched. $\times 1,750$

into one or several well-defined bodies tending to occupy one or other end, side or centre of the nucleus. More or less of a definite ring-zone appears, depending partly on the relative size of the nucleus and its chromatic mass(es), and partly on the degree to which the nucleolar material lies close to the nuclear membrane away from the chromatic mass or continues to intertwine with or dissect the latter. Heidenreich is mistaken in believing that the chromatic mass shrinks and, therefore, becomes denser and more Feulgen-positive, in the course of the disease. There are a tremendous growth and increase in amount and concentration of both the protein and deoxyribonucleic acid of the masses.

There is no simple coagulation or fusion of chromatin granules (as stated by Hughes⁷) to give a chromatic mass as strongly Feulgen-positive as the chromatin granules themselves, or staining with the same intensity or colour with toluidine blue or Giemsa. When first formed, the chromatic mass is almost completely Feulgen-negative and achromatic, and with toluidine blue stains a pale-greenish wash. Were its origin from the chromatin granules, it could only be from dispersing material of 'disintegrating' granules, which would lose their strongly Feulgen-positive and chromatic nature. In many nuclei the cytological picture partly suggests this; that is to say, at the time the chromatic mass first appears, the chromatin granules may be very small, irregular and dispersed. But the evidence goes no further than that. In my material the chromatin granules of the fat cells, for example of *A. grossulariata* and *L. dispar*, were large, definite and discrete chromosome-nucleoli (Fig. 1); and in *A. grossulariata* in particular, but also in the majority of *L. dispar* nuclei, they remained so throughout the formation of the chromatic mass. In *A. grossulariata* they remained so right up to the maximum growth and enrichment of the chromatin net with deoxyribonucleic acid. In *L. dispar* they tended to unravel as the chromatic net grew. In *Pyrausta nivalis* the numerous chromatin granules, though definite and discrete, were smaller than in *L. dispar* and *A. grossulariata*. Apart from those on the nuclear membrane, they were intimately associated with the very elongated nucleoli. Throughout the formation and most of the growth of the chromatic net, the granules did not tend to unravel. In none of the material examined was any evidence found that the chromatic mass had been formed from the chromatin, whether this existed as unmistakable chromosome-nucleoli, or was unravelled to various extents. Indeed, as already noted, in the bulk of the nuclei of certain tissues the chromatin granules remained as chromosome-nucleoli throughout the formation and most of the growth of

the chromatic masses. The cytology of the nuclear polyhedroses of the gut and of the other tissues, in the Lepidoptera and in the sawfly, were found to be essentially the same. From these observations it is concluded that the chromatic masses of these nuclear diseases do not arise by fusion of chromatin granules but are produced *de novo*.

In Carnoy-fixed material of the peculiar nuclear polyhedrosis of the blood cells of *Tipula paludosa*, I have found⁸ that the chromosomes of the telophase cluster elongate and become applied to the nuclear membrane. A proteinaceous inclusion body, almost completely Feulgen-negative, forms in the nuclear sap. It enlarges and becomes deeply Feulgen-positive. At, or just prior to, polyhedron formation the chromosomes become detached from the nuclear membrane. All the evidence so far obtained points strongly to the central body as the site of formation of virus rods. In this disease, as in those of the Lepidoptera and sawflies, the chromatin may play an important, even 'secretory', part in the formation of the virus-producing inclusion bodies; but the latter do not seem to arise directly from the chromatin material.

The material of the chromatic mass, almost from its very formation, is recognizable as an exceedingly

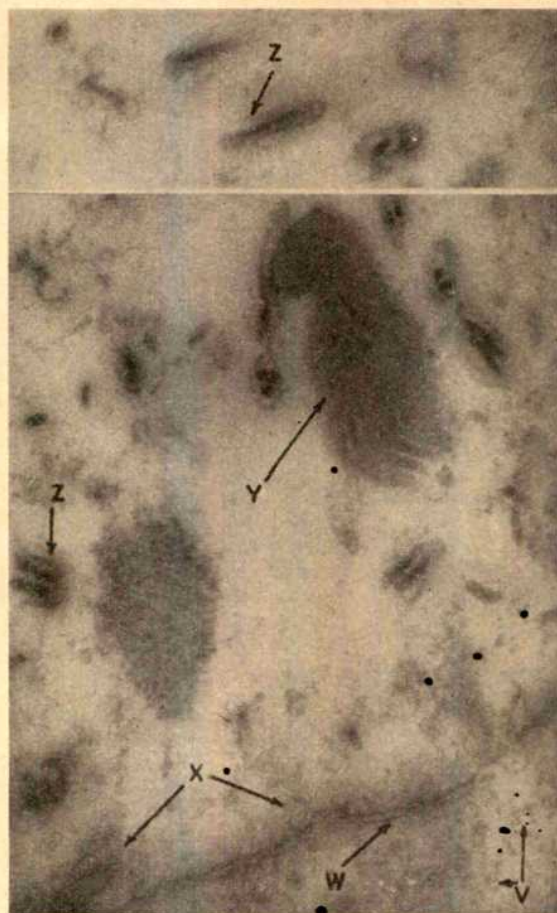


Fig. 2. Portion of fat-body cell of *Lymantria dispar* at early stage of polyhedron formation. V, cytoplasmic granules. W, nuclear double membrane. X, vesicles attached to nuclear membrane. Y, developing polyhedron with occluded virus rods in capsules. Z, incompletely formed capsule membranes surrounding virus rods. $\times 50,000$

Electron micrograph taken by Mr. R. H. Howe, Cavendish Laboratory, Cambridge

fine three-dimensional network and retains this basic structure throughout its further enrichment with protein and deoxyribonucleic acid, though the network is obscured when it is most heavily laden with virus. No ribonucleic acid has been detected in it at any stage of its development. During the development of the chromatic mass the nucleoli tend to be vacuolated. In the course of the disease the ribonucleic acid and protein of the cytoplasm increase markedly.

The chromatic net retains its basic structure until most of the deoxyribose nucleoprotein virus formed on it has been set free into the ring-zone; one cord of it after another may then dissolve and the mass expand and take on the appearance of a coarse network during the period of polyhedron formation. In fine sections of *L. dispar* fat body, it has been found that no virus rods are present on the fine chromatic net when it is first formed. The virus rods form in the cords and are later freed into the ring-zone. Virus may aggregate and polyhedra also form in large pores of the early net. In *L. dispar* the density of freed virus rods is far higher in some of these pores than in the ring-zone. Due to this, the number of virus rods which associate together to form a single bundle is much greater in the former position. It has also been found in *L. dispar* that the inner capsule membranes form around the freed individual rods or aggregates of them, surrounding one end

first and then gradually completely enclosing them (Fig. 2). Synchronously the capsular protein, which is not as electron-dense as the polyhedral protein in the osmic-fixed material, is deposited within the more or less completely formed part of the capsule membrane. Somewhat prior to the formation of capsules on the freed virus rods, large numbers of peculiar 0-shaped vesicles 30–70 mμ in size appear in the ring zone. By the end of polyhedron formation many of these seem to have been transformed into 'ribbons' about 500 mμ × 12 mμ in size. The nuclear boundary of the fat cell is a double membrane.

I am indebted to Dr. K. M. Smith for the diseased sawfly larvæ and many of the other viruses, to Dr. R. Markham for the samples of ribo- and deoxyribonucleases used in this work, and to Prof. G. Causey and Dr. H. Hoffman for making available technical facilities at the Anatomy Department of the Royal College of Surgeons for cutting the sections for the electron microscope. [Jan. 3

¹ Marzocchi, V., *Arch. de Parasit.*, 12, 456 (1908).

² Glaser, R. W., *Ann. Ent. Soc. Amer.*, 20, 319 (1927).

³ Paillot, A., *C.R. Acad. Sci., Paris*, 180, 1139 (1925); *Ann. Inst. Pasteur*, 40, 314 (1926).

⁴ Heidenreich, E., *Arch. f. Ges. Virusforsch.*, 1, 582 (1940).

⁵ Bird, F. T., *Biochim. Biophys. Acta*, 8, 360 (1952).

⁶ Xeros, N., *Nature*, 172, 309 (1953).

⁷ Hughes, K. M., *Hilgardia*, 22, 391 (1953).

⁸ Smith, K. M., and Xeros, N., *Proc. Int. Cong. Electron Microscopy* (1954) (in the press).

CONDUCTIVITY INDUCED BY X-RAYS IN POLYETHYLENE TEREPHTHALATE: A POSSIBLE INSULATOR FOR RADIOLOGICAL APPARATUS

By J. F. FOWLER and DR. F. T. FARMER

Radiotherapy Department, Royal Victoria Infirmary, Newcastle upon Tyne 1

MEASUREMENTS of the conductivity induced by X-rays in 'Melinex' (polyethylene terephthalate sheet) have been made, using the d.c. amplifier technique previously described^{1,2}. The specimens consisted of sheets of 'Melinex' film 0.03 mm. in thickness placed in a chamber that could be evacuated. The magnitudes of the static and induced conductivities have been measured in addition to the dependence of induced conductivity upon temperature and dose-rate, and the shape of the decay curve after irradiation.

The induced currents are smaller than in any of the other materials we have investigated; the equilibrium induced current varies with dose-rate in a way that follows more nearly a linear than a square root law; and when irradiation ceases, the current falls within a few seconds to a small fraction of the equilibrium value. These three characteristics lead us to distinguish 'Melinex' on one hand from the class of insulating materials such as 'Perspex' (plasticized) and some types of amber³, which follow almost exactly a linear law, and on the other from the class of materials described recently³ having $\Delta = 0.6$ (see equation (1) below). The second class includes polystyrene, polytetrafluoroethylene, unplasticized 'Perspex', and polyethylene. The division cannot be regarded as rigid, and both polyethylene and 'Melinex' tend to 'bridge' the gap, with 'Melinex' closer to the first-mentioned class and polyethylene closer to the second.

Dependence on dose-rate. In the relationship between equilibrium induced current i_x and dose-rate, R ,

$$i_x \propto R^\Delta \quad (1)$$

we find $\Delta = 0.83 \pm 0.05$ for 'Melinex' film, over the range $R = 6-64$ r./min., and between 20° C. and 100° C. This value of Δ is close to that of polyethylene³, for which $\Delta = 0.80 \pm 0.05$. An exponential distribution of trapping-levels in energy below the conduction band is therefore to be expected, the number of traps N_W between W and $W + dW$ electron volts below the conduction band being given by

$$N_W = A \exp(-\alpha W) \quad (2)$$

where A is a constant. The theory of photoconductivity from which we have previously drawn analogies gives

$$\alpha = 1/kT_1 \quad (3)$$

where k is Boltzmann's constant and T_1 is an arbitrary temperature, characteristic of the material. In addition,

$$\Delta = T_1/(T + T_1) \quad (4)$$

so that α can be determined from the observed value of Δ .

For 'Melinex' at 50° C., it is found that $T_1 = 1,700^\circ \text{K.}$ and $\alpha = 6.8$. The number of traps at a given depth below the conduction band therefore falls

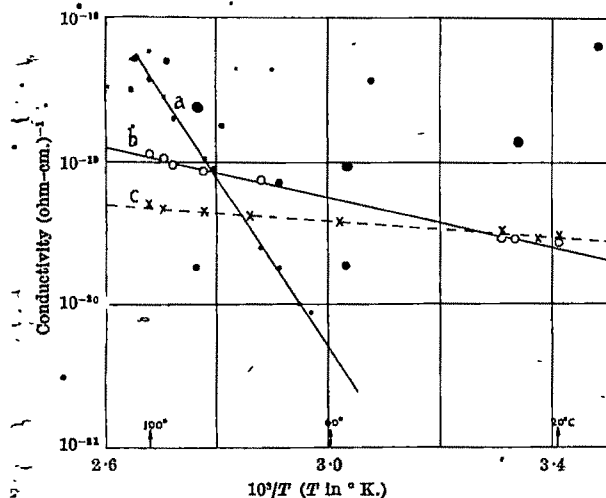


Fig. 1

to one-half for each 0.1 eV. increment of depth. The corresponding decrease in the case of polyethylene ($\Delta = 0.8$) is to one-third. (In polystyrene ($\Delta = 0.6$), the number of traps falls to 7 per cent for each increment of 0.1 eV. (class 2), whereas in a material with $\Delta = 1$ the distribution of traps is constant with depth.)

The variation of Δ with temperature T given by equation (4) is in fact observed for 'Melinex', as in the case of polytetrafluoroethylene and polystyrene².

Dependence on temperature. Fig. 1 shows the graphs of $\log$ (conductivity) of 'Melinex' plotted against the reciprocal of absolute temperature. The resulting straight lines are of slope proportional to the activation energy W , according to the general formula

$$\sigma = \sigma_0 \exp(-W/kT) \quad (5)$$

In the case of static conductivity (that is, with no incident radiation; Fig. 1a) $W = 1.3$ eV. This is a similar activation energy to those found in the other insulating plastics we have studied. For the equilibrium-induced conductivity under X-irradiation (Fig. 1b) at $R = 7$ r./min., the slope corresponds to an activation energy $W = 0.2$ eV. This is considerably less than the materials of class 2 above ($W = 0.5$ eV.), and less than for polyethylene, for which $W = 0.35$ eV.

Plasticized 'Perspex' and moulded amber, however, have been found to show even less dependence of i_x upon temperature than 'Melinex', and this is explained not necessarily by a small activation energy, but by a uniform distribution of traps. Using the exponential distribution derived above for 'Melinex', the induced current would be expected to increase by a factor of 3 between 20° and 80° C. The observed increase is in good agreement (Fig. 1b).

Effect of removing air. When the specimen was kept under vacuum at 60° C. for several hours prior to irradiation, the dependence of i_x upon temperature became markedly less, an increase of only $1\frac{1}{2}$ being observed between 20° and 80° C. The magnitude of the induced current decreased, but only at the higher temperatures (Fig. 1c). This observation is consistent with the removal, as the specimen chamber is evacuated, of some of the shallower traps (< 1 eV.), making the distribution more nearly uniform. These traps are probably due to the presence of adsorbed gas⁵. The same phenomenon occurs to an even

greater extent in 'Perspex', but scarcely at all in polyethylene, polystyrene or polytetrafluoroethylene.

Decay of the induced current. As in the other plastics studied, the conductivity persists after switching off the radiation, decaying rapidly at first and then more slowly. In 'Melinex' the rapid decay is to between 1/3 and 1/20 (depending on temperature and dose-rate) and it occupies only a few seconds; in this respect it is similar to polyethylene. The equilibrium conductivity in polyethylene, however, and therefore the current remaining after the initial rapid decay, is much greater (10^3 – 10^4 times) than in 'Melinex'.

The subsequent decay follows the general hyperbolic relation

$$\frac{1}{i} = \frac{1}{i_x} + Ct \quad (6)$$

where i is the current at time t after irradiation ceases, and C is characteristic of the material, varying slowly with temperature. This equation is valid between $t \approx 5$ min. and $t \approx 5$ hr.

Plotting reciprocal fraction of current against time gives $C = 20$ min.⁻¹ for 'Melinex' at 85° C., so that the time taken for decay from 10 per cent to 1 per cent would be 20×90 min., that is, 30 hr., if equation (6) remained valid. It is found, however, that the decay becomes approximately exponential at longer times, so that 'Melinex' at 85° C. shows virtually complete recovery after about twelve hours. At lower temperatures, this slow decay takes much longer, but is still much more rapid than in polytetrafluoroethylene and polystyrene; and, of course, the currents remaining in 'Melinex' at these long times are extremely small.

Under vacuum the initial rapid decay is even greater, the fraction i/i_x remaining after 1 min. being reduced by a factor between 2 and 10, depending on temperature and dose-rate. This accords with the deduction above that some of the less deep traps are removed. Thus, under vacuum, 'Melinex' becomes less like polyethylene, and more like the materials of class 1.

Application to radiology. Polyethylene terephthalate appears to be basically suitable as a high-insulation material for use in condensers or radiological instruments which operate in the presence of ionizing radiation. This suitability is due to: (a) its high natural insulation; (b) its low induced conductivity; and (c) the initial rapid decay of the induced current, after irradiation, to very small values. Its performance in all these respects is improved if the insulator is operated under a vacuum, but this condition can, of course, seldom be met in practice.

Polyethylene terephthalate is not yet made in the form of rods or blocks, but the 'Melinex' sheet already available may find applications in condenser construction. Further tests of dielectric strength, mechanical properties, and incidence of flaws would, of course, be required to assess more fully its potential uses as an insulating material.

We thank I.C.I., Ltd. (Plastics Division, Welwyn Garden City), for their co-operation in supplying the samples of 'Melinex' film. [Dec. 22]

¹ Fowler, J. F., and Farmer, F. T., *Nature*, **173**, 317 (1954).

² Fowler, J. F., and Farmer, F. T., *Nature*, **171**, 1020 (1953); **174**, 136 (1954); **174**, 300 (1954).

³ Fowler, J. F., and Farmer, F. T., *Nature*, [175, 516 (1955)].

⁴ Rose, A., *R.C.A. Rev.*, **12**, 362 (1951).

⁵ It is known that oxygen modifies the photoconductivity of thallium sulphide by providing electron-trapping sites; von Hippel, A., and Rittner, E. S., *J. Chem. Phys.*, **24**, 372 (1946).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Promotion of Incorporation of Amino-acids by Specific Di- and Tri-nucleotides

When disrupted staphylococcal cells are incubated with ^{14}C -labelled amino-acids and a source of energy, the radioactive amino-acids become incorporated into the protein of the preparation. When only one amino-acid is present in the incubation mixture, incorporation appears to take place by a process of exchange occurring between the added ^{14}C -labelled amino-acid (or a metabolite thereof) and corresponding residues in the cell protein. In many cases the incorporation can be largely abolished by removal of nucleic acid from the disrupted cells, and then restored by addition of staphylococcal nucleic acid; but the magnitude of these effects varies with the amino-acid the incorporation of which is being studied¹. These differing effects could be explained if the incorporation of specific amino-acids were activated by specific portions within the polynucleotide structure, some parts of which were more easily damaged, or replaced, than others.

The incorporation of glycine or aspartic acid can be activated by addition of nucleic acid from staphylococci but not from other cells. Staphylococcal nucleic acid is not inactivated by digestion with ribonuclease, whereas nucleic acids from yeast or liver become active after such digestion. Therefore we have proceeded to fractionate ribonuclease digests of staphylococcal ribonucleic acid, using chromatography and ionophoresis on paper as described by Markham and Smith², in an attempt to separate the fractions in the digests which are necessary for activation of the incorporation of certain amino-acids under exchange conditions. Disrupted staphylococcal cells have been prepared and depleted of nucleic acid as previously described¹, and the rates of incorpora-

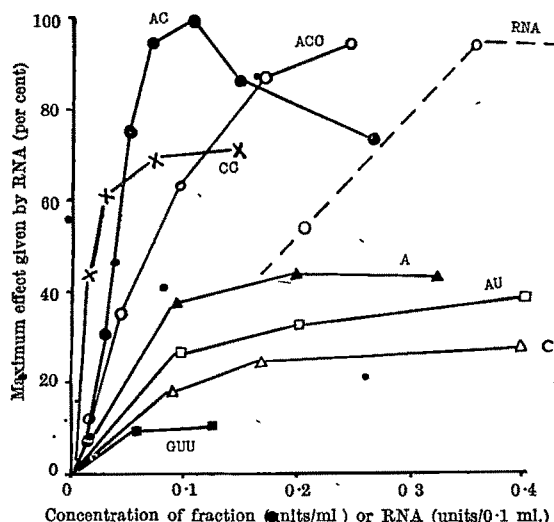


Fig. 1. Replacement of ribonucleic acid by nucleotides for the activation of aspartic acid incorporation in disrupted staphylococci. Incubation mixture contains buffered saline pH 6.3, adenosine triphosphate, hexosediphosphate, ^{14}C -labelled aspartic acid, and staphylococcal ribonucleic acid or nucleotides as indicated (A = adenylic, G = guanylic, C = cytidylic, U = uridylic acid). 1 unit = amount of material having extinction 1.0 at 260 m μ . Ribonucleic acid concentrations reduced to 1/10

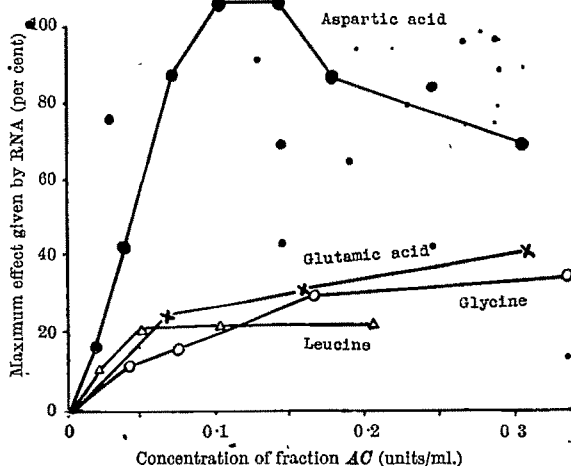


Fig. 2. Action of AC (adenine-cytosine dinucleotide) in replacing ribonucleic acid for the activation of incorporation of various amino-acids in disrupted staphylococci

tion of ^{14}C -labelled aspartic acid, etc., determined in the presence and absence of ribonucleic acid or fractions obtained from digests thereof. Active materials have been identified by reference to the data given by Markham and Smith², and by estimation of the purine bases or pyrimidine nucleotides liberated by hydrolysis in *N* hydrochloric acid. In the cases so far investigated, of aspartic acid, glutamic acid, glycine and leucine incorporation, it has been possible to replace ribonucleic acid by materials occurring in the di- or tri-nucleotide fractions.

Fig. 1 shows the effect of various nucleotide fractions in activating aspartic acid incorporation; A, G, U, C refer to adenylic, guanylic, uridylic and cytidylic acids respectively. The fraction 'AC', which contains adenine-cytosine dinucleotide, completely replaces ribonucleic acid and, compared on a basis of optical density at 260 m μ , is 110 times as active as the whole ribonucleic acid. Many of the fractions tested showed some activity for aspartic acid incorporation, but, except in the cases of AC and ACC, the replacement of ribonucleic acid was only partial; thus C gave 25 per cent and either A or AU 50 per cent replacement of the ribonucleic acid effect. Replacement by the fractions reaches a plateau value and decreases again at high concentrations; even in the most effective cases (see AC in Fig. 1) complete replacement is obtained over only a short range of concentration. Fig. 2 shows the action of AC in replacing ribonucleic acid for activation of the incorporation of other amino-acids; complete replacement is obtained only in the case of aspartic acid of the four amino-acids tested.

Ribonucleic acid can again be replaced by small polynucleotides for the promotion of glycine, glutamic acid or leucine incorporation, but different fractions are required in each case. The fractions involved in the incorporation of glutamic acid and leucine have been tentatively identified as GU₂ and AU₂ respectively. Work is proceeding on the identification of fractions involved in promotion of the incorporation of other amino-acids.

It is clear that incorporation reactions for specific amino-acids can be activated by specific combinations of nucleotides, and it is probable that the effect of ribonucleic acid lies in the presence of these combinations within the polynucleotide structure. Since activation by whole ribonucleic acid appears to be species-

specific¹, it would follow that incorporation in species-specific proteins depends upon the order of these combinations of nucleotides in the corresponding nucleic acids, and that an experimental basis for something approaching a nucleic acid-template of the nature postulated by Dounce³ and others is beginning to appear.

We are grateful to Dr. R. Markham for advice and guidance in separating and identifying nucleotide fractions.

ERNEST F. GALE
JOAN P. FOLKES

Medical Research Council
Unit for Chemical Microbiology,
Department of Biochemistry,
University of Cambridge.
Jan. 27.

¹ Gale, E. F., and Folk, J. P., *Nature*, 173, 1223 (1954); *Biochem. J.*, 59, 661, 675 (1955).

² Markham, R., and Smith, J. D., *Biochem. J.*, 52, 558 (1952).

³ Dounce, A. L., *Enzymologia*, 15, 251 (1952).

Anomeric Inversions by Glycosidases

β -AMYLASE has so far been considered a unique case among hydrolytic enzymes, as its action is accompanied by an inversion of the anomeric configuration of the splitting product produced; that is, β -maltose is formed from amylose, contrary to expectation. From our experiments it seems that two more glycosidases exist capable of analogous anomeric inversions.

Because of their close relationship to amylose, the following substrates were chosen, all three consisting of glucose chains with α -glucosidic linkages: (I) *cyclohexaglucon*; (II) *cycloheptaglucon*; (III) maltose.

The mode of action of takadiastase on all three substrates and of pancreatin on maltose was investigated (the *cyclodextrins* are not attacked by pancreatin) with the following results.

(1) There are indications that two specific '*cyclodextrinases*' ('*cyclohexa-*' and '*cyclohepta-gluconase*') are present in takadiastase. By precipitating with ammonium sulphate it was possible to obtain five fractions (A to E, in order of increasing concentrations of ammonium sulphate) with varying ratios of activities (R) towards *cyclohexa-* and *cyclohepta-glucon* as shown in Table 1.

(2) These '*cyclodextrinases*' are not identical with either taka-amylase or takamaltase. Table 1 reflects also non-parallel variations and partial separation of the respective activities towards starch, maltose and the *cyclodextrins*.

Table 1. Activities of takadiastase fractions obtained by precipitating with increasing concentrations of ammonium sulphate and dissolving the precipitates in equal volumes of water. The table includes a fraction A which was obtained in a different set of experiments. The activities are expressed in terms of initial drop in optical rotation per min. per ml. enzyme fraction, the activity of the original takadiastase arbitrarily taken as 100. R = ratio of activities towards *cyclohexa-* and *cyclohepta-glucon*

		Fractions					Orig. takadiastase
		A	B	C	D	E	
Activity towards	starch	23	36	33	33.5	27	100
	maltose	0	0	0	0	63	100
	<i>cyclohexa-glucon</i>	0	25	70	45	2	100
	<i>cyclohepta-glucon</i>	0	13	27	21	15	100
R			1.9	2.6	2.2	0.134	1

Table 2. Maximal mutarotations during enzymatic hydrolysis of *cyclodextrins* and maltose by takadiastase and pancreatin respectively. *Italic figures* for rotation after addition of alkali

Enzyme Substrate	Taka- diastase <i>cycloHexa- glucon</i>	Taka- diastase <i>cycloHepta- glucon</i>	Taka- diastase Maltose	Pan- creatin Maltose
Initial rotation	+4.86° <i>+4.89</i>	+1.09° <i>+1.07</i>	+3.57° <i>+3.56</i>	+2.89° <i>+2.87</i>
Rotation at stage of maximal muta- rotation	+4.06 <i>+4.16</i>	+0.72 <i>+0.61</i>	+3.32 <i>+3.41</i>	+2.68 <i>+2.51</i>
Final rotation	+2.03 <i>+2.01</i>	+0.37 <i>+0.37</i>	+2.59 <i>+2.59</i>	+1.27 <i>+1.26</i>
Value of maximal mutarotation	+0.10	-0.11	+0.09	-0.17

(3) Calcium ions are specific activators of the two '*cyclodextrinases*'. The activity of takadiastase towards the two *cyclodextrins* was considerably weakened by dialysis against distilled water (but not against tap water). The original activity could be restored by addition of either tap water or 0.1 N calcium salts. The calcium ions could also be replaced by strontium ions for reactivation. The activity could not be restored by addition of the following ions also present in tap water: phosphate, sulphate, chloride, hydrocarbonate, magnesium, ferrous iron and sodium.

The mutarotations observed during the enzymatic hydrolysis of the two *cyclodextrins* and of maltose by takadiastase and pancreatin respectively are summarized in Table 2.

Addition of alkali served to stop the hydrolysis at any stage and to accelerate the mutarotation of the sugars so far liberated¹. Accordingly, the values 'after addition of alkali' represent the rotation after attaining mutarotational equilibrium of the splitting products.

(4) Upward mutarotation was observed during the action of takadiastase on *cyclohexaglucon* though the original substrate contains no β -glucosidic linkages.

(5) Downward mutarotation was observed during the action of takadiastase on *cycloheptaglucon* according to expectation.

(6) Downward mutarotation was observed during the action of pancreatin on maltose, corresponding to liberation of α -glucose in accordance with expectation.

(7) Upward mutarotation was observed during the action of takadiastase on maltose, corresponding to liberation of β -glucose, contrary to expectation.

Observations (4) and (7) suggest that anomeric inversions are brought about by the two glycosidases involved (takamaltase and '*cyclohexagluconase*') concomitantly with their hydrolytic action, in analogy with the inversion observed with β -amylase.

I hope to publish a full account of this work elsewhere, together with Dr. J. Leibowitz, of Jerusalem, to whom I am indebted for help and advice. A part of this work was supported by a British Council Scholarship.

E. BEN-GERSHON

Department of Organic Chemistry (B),

The Hebrew University,

Jerusalem,

and

Department of Biochemistry,

University of Cambridge.

Nov. 10.

¹ Kuhn, R., *Ann.*, 443, 1 (1925).

Paper Electrophoresis of a Purified Specific Antibody

RECENTLY, several workers¹ have tried to fractionate gamma-globulins and immune sera by electrophoresis. Such experiments have only given the mean properties of all gamma-globulin proteins, since non-antibody as well as antibody proteins occur in immune sera. We have now carried out paper electrophoresis of a purified specific antibody.

Antigenic azo-globulin was prepared by isolating pseudoglobulins from beef serum using ammonium sulphate², and coupling with diazotized anthranilic acid. Four rabbits were immunized as previously described³, and, when a high antibody titre was established, these were killed by exsanguination and antibody precipitated from the antiserum with homologous antigen. The antibody was separated from the complex using sodium chloride solution and 0.1 *N* hydrochloric acid, as previously described⁴, and the antibody estimated by micro-Kjeldahl nitrogen determination. Paper electrophoresis was carried out with a Jouan Paris, model 1603, apparatus and No. 204 papers measuring 400 mm. $\times$ 27.5 mm. Alkaline conditions (300 V., 100 m.amp., 6 hr., with a veronal-sodium veronal buffer, pH 8.8) and acid conditions (200 V., 100 m.amp., 5 hr., with a sodium veronal-acetate buffer, pH 4) were both used⁵. In each experiment we ran one strip with 0.1 ml. normal human serum as a control, and two strips with 0.05 ml. of antibody solution (825 mgm. protein/100 ml.). After electrophoresis, the strips were dried at 90°, stained for 15 min. in a bromphenol blue solution (0.2 gm. dye and 65 gm. mercuric chloride in 200 ml. 96 per cent ethanol), washed in tap water and dried at 100°. Colour intensity was measured with an optical densitometer. Pure antibody showed a single homogeneous peak at both acid and alkaline pH, corresponding at alkaline pH to the peak of the serum gamma-globulin.

SHEVKET TEKMAN
AYTEN UGUR

Department of Biological Chemistry,
University of Istanbul,
Turkey.
Nov. 30.

¹ Cann, J. R., Brown, R. A., and Kirkwood, J. G., *J. Amer. Chem. Soc.*, **71**, 2687 (1949); *J. Biol. Chem.*, **181**, 161 (1949). Cann, J. R., Brown, R. A., Kirkwood, J. G., and Hink, J. H., *J. Biol. Chem.*, **185**, 663 (1950). Cann, J. R., Campbell, D. H., Brown, R. A., and Kirkwood, J. G., *J. Amer. Chem. Soc.*, **73**, 4611 (1951). Jankovic, B. D., and Krijnen, H. W., *Nature*, **171**, 982 (1953).

² Haurowitz, F., Sarafian, K., and Schwerin, P., *J. Immunol.*, **40**, 391 (1941).

³ Haurowitz, F., *J. Immunol.*, **43**, 331 (1942).

⁴ Haurowitz, F., and Tekman, S., *Nature*, **157**, 335 (1946). Haurowitz, F., Tekman, S., Bilen, M., and Schwerin, P., *Biochem. J.*, **41**, 304 (1947).

⁵ Michells, L., *Biochem. Z.*, **234**, 139 (1931).

Neuromuscular Block caused by Acetylcholine

It has long been known that large doses of acetylcholine may cause a neuromuscular block¹. This block has been thought to be due to the ability of acetylcholine to depolarize persistently the end-plate regions of the muscle fibres². No direct studies on the relation of such a neuromuscular block to the muscle membrane potential have, however, been carried out.

In the present investigation this relationship has been studied on the sartorius nerve-muscle prepara-

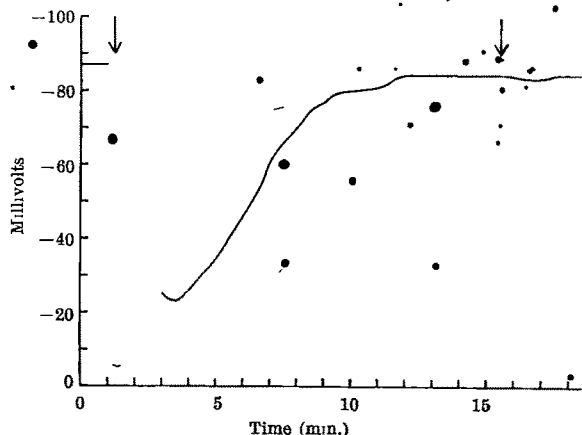


Fig. 1. Continuous registration of the membrane potential at the end-plate region of a single muscle fibre. At the arrows, acetylcholine iodide was added to the muscle bath, giving a concentration of 10×10^{-6} and 20×10^{-6} *M*.

tion of the frog (*Rana temporaria*). The membrane potentials and the end-plate potentials of single muscle fibres were recorded with capillary micro-electrodes of external tip diameter less than 0.5 μ , filled with 3 *M* potassium chloride (for details of technique see ref. 3).

In the presence of 1×10^{-6} *M* neostigmine bromide, acetylcholine iodide (Hoffmann-La Roche) in a concentration of $5-20 \times 10^{-6}$ *M* caused a neuromuscular block. When the initial fibrillary twitches of the muscle fibres had subsided (about 60 sec.), the tip of the microelectrode was re-inserted at the end-plate region of a single muscle fibre and the membrane potential continuously recorded. These concentrations of acetylcholine caused a considerable reduction of the membrane potential at the end-plate region. Without removal of the acetylcholine the depolarization, however, spontaneously subsided and the membrane potential was restored to its original value within 7-15 min. as shown in Fig. 1. A subsequent addition of acetylcholine to the bath did not significantly change the membrane potential.

During the period of depolarization, a neuromuscular block developed and persisted despite repolarization of the membrane to the normal level. End-plate potentials could sometimes be recorded during the phase of depolarization, but never in the later phase when the membrane potential again was normal. The neuromuscular transmission remained completely blocked so long as acetylcholine was in the muscle bath and could only be restored slowly by washing the muscle in Ringer's fluid for 15-45 min. During the period of washing, the membrane potential remained normal and, preceding the relief of block, end-plate potentials again appeared. These end-plate potentials were markedly increased in size by repetitive stimulation of the motor nerve, and eventually an action potential could be elicited (Fig. 2).

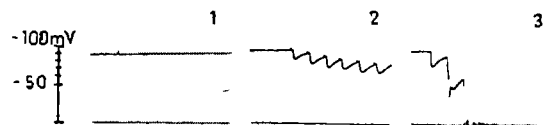


Fig. 2. (1) End-plate potentials have disappeared during the later phase of the neuromuscular block caused by 10×10^{-6} *M* acetylcholine iodide. (2) After washing the muscle with Ringer's fluid, end-plate potentials are recorded which are increased in size by repetitive stimulation of the motor nerve and which may lead to an action potential. (3) Time, 5 m sec.

In the absence of neostigmine, a qualitatively similar neuromuscular block was caused by acetylcholine in about ten times higher concentrations. The observed changes of the membrane potential were only seen at the end-plate region and not in the nerve-free part of the muscle fibre. Concentrations of choline corresponding to the amounts of acetylcholine used had no detectable influence on the membrane potential or on the neuromuscular transmission.

It is concluded that prolonged neuromuscular block caused by acetylcholine in the sartorius muscle of the frog is not due to a persistent depolarization of the end-plate regions or of the adjacent membrane of the muscle fibres. The block is, on the contrary, characterized by a decreased sensitivity of the end-plate regions to the transmitter substance.

S. THESLEFF

Institute of Physiology and
Department of Pharmacology,
University of Lund.
Nov. 19.

¹ Brown, G. L., Dale, H. H., and Feldberg, W., *J. Physiol.*, **87**, 394 (1936). Brown, G. L., *J. Physiol.*, **89**, 220 (1937).

² Burns, B. D., and Paton, W. D. M., *J. Physiol.*, **115**, 41 (1951); Riker, W. F., *Pharm. Rev.*, **5**, 1 (1953).

³ Nastuk, W. L., and Hodgkin, A. L., *J. Cell. Comp. Physiol.*, **35**, 39 (1950). Fatt, P., and Katz, B., *J. Physiol.*, **115**, 320 (1951).

Palatability of N-Oxides of Pyrrolizidine Alkaloids as a Factor in *Senecio* Poisoning

RECENT chemical studies revealed that pyrrolizidine alkaloids are accompanied in the plants by their N-oxides¹. In young growing plants, N-oxides may constitute more than 90 per cent of the alkaloid content, while in the autumn the proportion may be reversed².

Plants containing pyrrolizidine (*Senecio*) alkaloids have long been known to be responsible for poisoning livestock when present in pastures in various countries³. How the poisoning occurs is obscure, as animals usually refrain from eating poisonous plants. However, Theiler observed horses to consume fair amounts of *Senecio* plants in early spring.

During experimental studies on the induction of liver cirrhosis and primary liver tumours in rats treated with various *Senecio* alkaloids⁴, administration of retrorsine, and of its N-oxide, isatidine, in drinking water disclosed a striking difference in the palatability of these two compounds. While rats abstained from drinking solutions of retrorsine containing more than 0.03 mgm./ml., they readily consumed tenfold more concentrated solutions of isatidine. As a result, high incidence of morbidity and mortality was observed among the young rats in the isatidine series, even though the isatidine treatment was discontinued after three weeks⁵.

Isatidine acts insidiously, and may induce pathological changes several weeks or months after its administration. The following example illustrates this delayed action. Four young rats, weighing 65–70 gm., were injected intraperitoneally with isatidine, 4, 10, 28 and 40 mgm. per rat respectively. All survived at least four weeks, though the rats which received the two higher doses grew rather slowly, became anæmic and listless. The rat which received 40 mgm. of isatidine in a single dose died on the thirtieth day after the injection. It had oedema of the subcutaneous tissues, a pale, enlarged, fatty

liver, and also pathological changes in the lung, spleen and pancreas. The rat which received 28 mgm. of isatidine developed bronchopneumonia, and was killed when *in extremis* on the forty-ninth day after the injection. It was very emaciated (weighed 90 gm.), had a dark, mottled, granular liver showing hæmorrhage and early fibrosis, and much hæmosiderin in the Kupffer cells; oedema of pancreas; congested lungs with brown hæmorrhagic petechiæ, and some pathological changes in the spleen and kidneys. These organs as well as the mesenteric hæmolymp nodes gave a positive Prussian-blue reaction for iron-containing pigment. The two rats injected with the smaller doses of isatidine did not develop pathological changes during four months following the injections. Young rats similarly injected with retrorsine (5–15 mgm./rat) died in the course of one to three days after the injection, showing predominantly necrotic and fatty changes in the liver; some had hæmorrhage into the stomach and small intestines.

These experiments seem to indicate that when young growing plants contain pyrrolizidine alkaloids in the form of N-oxides, they would be palatable and readily consumed by livestock, which may afterwards develop various pathological changes depending on the time of survival.

It remains to be shown whether the delayed pathological changes result from the action of the N-oxides as such, or from that of the respective alkaloids into which they may be converted by reduction in the animal body.

I am indebted to Prof. F. L. Warren, Chemistry Department, University of Natal, Pietermaritzburg, for a gift of pure crystalline retrorsine and isatidine, and to Dr. M. A. Ead for the microscopic evaluation of the pathological changes in the organs. My thanks are due to the British Empire Cancer Campaign for a grant.

R. SCHOENTAL

Cancer Research Department,
Royal Beatson Memorial Hospital,
Glasgow, C.3.
Dec. 15.

¹ Koekemoer, M. J., and Warren, F. L., *J. Chem. Soc.*, **66** (1951). Culvenor, C. C. J., Drummond, L. J., and Price, J. R., *Aust. J. Chem.*, **7**, 277 (1954).

² Areshkina, L. Ya, *Biochimiya*, **16**, 461 (1951).

³ Watt, J. M., and Brezer-Brandwijk, M. G., "The Medicinal and Poisonous Plants of Southern Africa" (Livingstone, Edinburgh, 1932).

⁴ Schoental, R., Head, H. A., and Peacock, P. R., *Brit. J. Cancer*, **[8]**, 458 (1954).

⁵ Schoental, R., *Voeding* (in the press).

Antibody Formation in Humans against their own Stored Red Cells

In the course of a study on factors that may be involved in the *in vivo* destruction of stored red cells, an experiment was performed which suggests that the antigenicity of red cells is altered when blood is kept for a long period of time under standard storage conditions, and individuals may be sensitized with such stored red cells.

In order to facilitate the presentation of the experimental work, the time of starting the experiment will be designated 'day 0' and the various operations will be referred to the starting day. 125 ml. of blood was withdrawn into 'Baxter' bottles from ten healthy individuals ranging in age

from twenty-one to thirty-two years. 10 ml. in addition were withdrawn at this time and the serum separated. The blood stood 42 days. During the course of a three-week period following the storage interval, six intravenous injections of 7-ml. quantities of the blood, two injections per week, were made into the individuals from whom the blood was obtained; that is, each individual was injected with his or her own stored blood. Ten days after the last injection (day 70) 20 ml. of blood was withdrawn from each individual; 10 ml. was placed in a bottle containing ACD solution, and the serum was separated from the remainder. Additional samples of blood were withdrawn and placed in ACD solution as the work continued. The blood in ACD solution was kept at $3^{\circ} \pm 1^{\circ} \text{C}$. and the serum samples were frozen at -18°C . The blood samples were prepared and handled using precautions to ensure sterility, and no contamination was detected during the course of the experiment. Red cells were obtained for testing by removing some blood from the storage bottle just before a test was carried out, washed three times in saline buffered at pH 7.3, and made up to a 1 per cent concentration.

Between days 71 and 77 the following tests were carried out using day 70 serum and day 0 and 70 red cells of the same individual: agglutination tests using saline and serum as diluents, and cells that had been treated with trypsin; haemolysis test with added complement; and the Coomb's test with normal and trypsin-treated cells (Coomb's test repeated on day 164). All the tests were negative. A short while later, the opportunity of utilizing the erythrophagocytic test² was made available. In this test the mixture of red cells and serum is added to a slide culture of phagocytic cells obtained from rabbit spleen. After a 30-min. period, fifty phagocytic cells are observed, and the percentage of them which have ingested red cells is referred to as the phagocytic index. Under normal conditions this ranges up to about 10; but when the red cells are sensitized by antisera, it is increased to 25 or more. The results cited were obtained on day 127. In six of the ten individuals, there was a significant increase in the phagocytic index when day 70 serum was mixed with old (day 0) red cells. There was no such increase when day 70 serum was mixed with fresh red cells, or when day 0 serum was mixed with old or fresh red cells. When day 70 serum was absorbed with old and with fresh red cells (one volume of serum plus one volume of the respective cells), the phagocytic index was markedly decreased after the single absorption with old red cells but was unchanged after absorption with fresh cells. The results obtained with old red cells are presented in Table 1. These results suggest that these six individuals produced antibodies against their own stored red cells.

The antigenic change in stored red cells may be due to an enzyme or enzymes in the blood, perhaps on the red cell itself, that acts on the red cell. The reason why positive results were obtained only with the erythrophagocytic test may be due to (1) the decreased ability of old red cells to react in some serological tests, (2) the production of small amounts of antibody with the particular injection procedure used, and (3) the possibility that the reaction can be detected only with a particular type or types of serological tests. These and related questions are under investigation.

If individuals can be sensitized with stored red cells, the problem of sensitization may have to be

Table 1. PHAGOCYTIC INDICES OF STORED (DAY 0) RED CELLS WITH SERA

Cells and serum of the same individual were tested. The phagocytic index recorded is the average of duplicate tests, both of which were in the same range in all cases

Experimental subject	Normal rabbit serum*	Serum obtained at start of experiment (day 0)	Serum obtained after injection procedure (day 70)	Day 70 serum absorbed with day 0 red cells	Day 70 serum absorbed with fresh red cells
Increased P.I.					
M. S.	4	13	20	14	22
G. G.	8	3	34	17	31
M. M.	12	9	22	8	25
J. H.	6	0	27	8	23
L. C.	10	6	30	18	22
R. S.	13	5	28	16	28
Average	9	6	28	12	25
No increase in P.I.					
K. R.	3	10	12	7	1
G. W.	7	13	1	4	9
L. N.	1	6	6	5	2
R. B.	9	13	9	11	10
Average	5	10	7	7	5

* Used as a control

considered in investigations directed toward preserving blood for longer periods of time than is possible at present. If, for example, a way is found of preserving blood for transfusion for two- or three-month periods and the antigenic changes are not inhibited, the recipient of the old blood may become sensitized to it and have a transfusion reaction with subsequent transfusions of old blood.

This investigation was supported in part by grant G-3444 of the National Institutes of Health. The assistance of Dr. James M. McFadden with the injections, and Dr. C. S. Wright and Mr. D. S. Mabry, who carried out the erythrophagocytic test, is gratefully acknowledged.

MERWIN MOSKOWITZ

Division of Bacteriology,
Department of Biological Sciences,
Purdue University,
Lafayette, Indiana.
Nov. 29.

¹ This is the 125-ml. size of a type of bottle in routine use for storing blood. Contained 40 ml. of ACD solution of following compositions: 1.38 gm. dextrose, 1.24 gm. sodium citrate and 0.45 gm. citric acid per 100 ml. Manufactured by Baxter Laboratories, Morton Grove, Illinois.

² Wright, C. S., et al., *J. Lab. and Clin. Med.*, 41, 160 (1953).

Coagulation Mechanism of the Horse

AN investigation has been made, by means of the newer coagulation tests, into the coagulation mechanism of horses' blood. As compared to human values, the most striking features are the greatly prolonged clotting time, poor clot retraction in spite of a platelet count within normal human limits and a prolonged one-stage prothrombin time.

Using the thromboplastin generation test¹, the prolonged clotting time was found to be due to a deficiency of antihæmophilic globulin, and this defect was present in both sexes. The deficiency was corrected by normal human plasma. This finding may well prove a most useful tool for those investigating hæmophilia in man. The horse is the only known animal exhibiting this defect, which is a species difference of great interest.

A full report of these findings will be published in due course elsewhere.

W. N. BELL
R. K. ARCHER
S. C. TOMLIN

Department of Medicine,
University of Cambridge,
and the
Equine Research Station,
Newmarket.
Jan. 24.

¹ Biggs, R., and Douglas, A. S., *J. Clin. Path.*, **6**, 23 (1953).

Pseudocholinesterase in Pacinian Corpuscles

WE have recently studied the distribution of cholinesterases in the cat's pancreas by Koelle's histochemical method¹, and observed that among other structures which contain enzyme the Pacinian corpuscles are prominent. The cholinesterase was seen to be concentrated in the core and stalk of this sensory organ (Fig. 1). By the use of appropriate substrates (acetyl- and butyryl-thiocholine) and a selective inhibitor (diisopropyl-fluoro-phosphate) the enzyme has been identified as pseudocholinesterase. Although the Pacinian corpuscles found in this situation are not pancreatic structures, being part of the enfolding mesentery, their location here is convenient because it is easier to section them when supported by the glandular tissue than when they are lying free in the mesentery.

So far as we are aware, the presence of pseudocholinesterase in Pacinian corpuscles has not previously been reported. Other nerve structures known to contain the enzyme are glial cells and the nuclei of certain ganglion cells^{1,2}. There is no reason for supposing that the enzyme is concerned in acetylcholine hydrolysis in the Pacinian corpuscles³ or at any of the other sites mentioned. It may be of importance, however, for the metabolism of the nerve tissue with which it is associated; and in this one structure which can be studied as an independent unit a means of testing this hypothesis is provided. It is not necessarily to be expected that inhibition of the enzyme (by, say, diisopropyl-fluoro-phosphate)

would produce immediate effects; but given *in vivo* over long periods, its excitability should certainly show a change if pseudocholinesterase has any important place in the function of nerve tissue. These considerations may be of importance in interpreting the biochemical lesions produced by anticholinesterases⁴.

We are indebted to Mr. G. Bull for the photomicrographs.

CATHERINE HEBB
KENNETH J. HILL

Agricultural Research Council
Institute of Animal Physiology,
Babraham Hall,
Babraham, Cambridge.

¹ Koelle, G. B., *J. Pharm. Exp. Ther.*, **100**, 158 (1950).

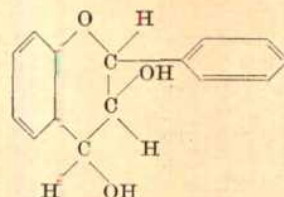
² Hebb, C. O., Silver, A., Swan, B., and Walsh, E. G., *Quart. J. Exp. Physiol.*, **38**, 185 (1954).

³ Gray, J. A. B., and Sato, M., *J. Physiol.*, **122**, 610 (1953).

⁴ Thompson, R. H. S., and Cavanagh, J. B., *Brit. Med. Bull.*, **10**, 47 (1954).

Formation of Leuco-Anthocyanins in Eucalypt Tissues

Robinson and Seshadri have postulated that $C_6-CH(OH)-CH(OH)-CH(OH)-C_6$ is the form of the precursor of the various classes of anthoxanthidins, and the anthocyanidins (for discussion, see ref. 1). Recent work² has shown that the leuco-anthocyanidins have the cyclic form of this structure:



so that this class could be one of the first forms of polyphenolic compounds synthesized in the plant and be the precursor of the above substances as well as catechins and tannins. If this were so, one would expect appreciable amounts of leuco-anthocyanins to be formed in areas of intense metabolism.

It has been possible to test this hypothesis by the examination of young leaves and of the cambial region of certain eucalypts. In the late spring and early summer the first-formed leaves of many young eucalypt stems are red to red-brown. Such leaves at various stages of development from several species, including *Eucalyptus sieberiana* F. Muell., *E. vlaeophora* F. Muell., *E. regnans* F. Muell., *E. obliqua* L'Hérit. and others, were examined. The youngest leaves were completely red except for the extreme tip, which was pale green and is probably the area of most active cell division. The body of the leaves contained anthocyanins and also appreciable quantities of leuco-anthocyanins, but the greatest amount of the latter was found

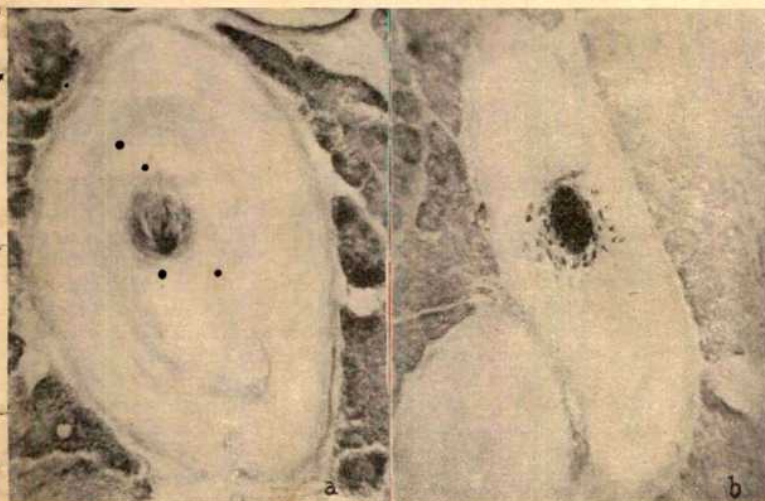


Fig. 1. Two sections (20 μ), at different levels, of a Pacinian corpuscle from a cat's pancreas. (a) Incubated with butyrylthiocholine in the presence of 10^{-3} M diisopropyl-fluoro-phosphate. (b) Incubated with butyrylthiocholine alone. In (a) there is no evidence of enzyme activity. In (b) the much more darkly staining core shows deposits of copper sulphide where hydrolysis of the substrate has occurred.

in the tips. The disappearance of the anthocyanin from the leaf and decrease of leuco-anthocyanins in the extreme tip appeared to occur simultaneously. The leuco-anthocyanin was always present in the leaves but decreased in amount as the leaves aged. Green areas appeared on either side of the midrib as the leaves became more mature. The red material (and probably the leuco-anthocyanin) was apparently transported elsewhere by means of the veins, which became noticeably red; but finally they, too, became green. The intensity of the red of the bark of the twigs to which the leaves were attached reached a maximum when the leaves became entirely green.

Another area of intense cell division and expansion is the cambial region. Again the hypothesis held, since in a log of *E. regnans* from which the bark was slipped readily, considerable amounts (1.3 per cent) of leuco-anthocyanidin were found in the cambial region; the phloem contained 1.8 and the sapwood 0.04 per cent. After the spring flush of growth had passed, leuco-anthocyanins were difficult to detect in the cambium.

In most tree species, the change of sapwood to heartwood is usually abrupt, and there is practically always a change in the colour of the wood and an increase in the amount and colour of the extraneous materials present in the cavities of the various cells, particularly the rays and vertical parenchyma cells. The heartwood is usually uniform, but occasionally samples of a species show a distinct outer heartwood zone (up to $1\frac{1}{4}$ in. wide); although this zone contains the same amount of total extractives, their properties differ from those of the inner heartwood. One theory of heartwood formation considers that the extractives are formed during the sudden burst of cell activity at the boundary between the sapwood and heartwood. In order to learn whether leuco-anthocyanins are formed in this region as they were in areas where cell division occurred, several cross-sections of jarrah (*E. marginata* Sm.) were examined. Sections 30 μ thick were taken every 1 cm. or less across the samples and analysed. An increase in leuco-anthocyanin occurred at the boundary; but instead of a temporary increase the value remained fairly constant across the outer heartwood zone, after which there was a steady decrease. Consequently it seems unlikely that the leuco-anthocyanins are synthesized at the sapwood-heartwood boundary, but are translocated to this locality, where the final changes to heartwood extractives would take place.

The leuco-anthocyanins were estimated by treating with propanol:3N hydrochloric acid (5:1) in a closed tube and determining the resulting anthocyanidin³. The anthocyanins present in the leaf were estimated separately. This method of detecting leuco-anthocyanins was more sensitive than methods which involve heating in an open vessel and more particularly those using aqueous acid. The above method has shown that mixtures of leuco-anthocyanins often occur in the tissues examined; and also by using standard conditions different rates of red colour formation have been shown by different raw materials. When pure leuco-anthocyanins from *Acacia melanoxylon* heartwood were subjected to this treatment and the transformation products examined by paper chromatography, these showed the presence of 3,3',4',7,8 pentahydroxy flavylum chloride, 3,3',4',7,8 pentahydroxy flavone, a substance which could be the undescribed 3,4',7',8 pentahydroxy

flavane and other substances. The formation of similarly related compounds by different acid treatments of leuco-anthocyanidins have been reported⁴. The extent to which the leuco-anthocyanin is converted to anthocyanidin, anthoxanthidin, catechin or tannin appears to depend on the extent of oxidation in the *in vitro* system. The different responses of different leuco-anthocyanins to such conditions may explain why unrelated members of these different classes are finally found in plant tissues.

Fuller details of this work will be presented elsewhere.

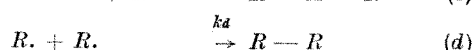
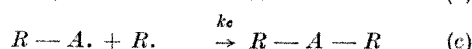
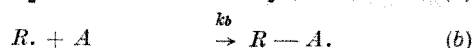
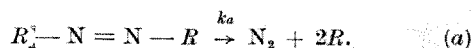
W. E. HILLIS

Division of Forest Products,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.
Dec. 6.

- ¹ Geissman, T. A., and Hinreiner, E., *Bot. Rev.*, **18**, 77 (1952).
² King, F. E., and Bottomley, W., *J. Chem. Soc.*, 1399 (1954). King, F. E., and Clark-Lewis, J. W., *Chem. and Indust.*, 751 (1954).
Bauer, L., Birch, A. J., and Hillis, W. E., *Chem. and Indust.*, 433 (1954). Swain, T., *Chem. and Indust.*, 1144 (1954).
³ Hillis, W. E., *J. Soc. Leather Trades Chem.*, **38**, 91 (1952).
⁴ Swain, T., *Chem. and Indust.*, 1144 (1954). Forsyth, W. G. C., *Nature*, **172**, 726 (1953).

Relative Reactivities of Substituted Anthracenes towards the Addition of 2-Cyano-2-propyl Radicals

2-CYANO-2-PROPYL radicals generated by thermal decomposition of azo-bis(isobutyronitrile) in benzene solution readily add on to the *meso*-positions of anthracene¹ or substituted anthracenes^{2,3} to form substituted 9,10-dihydroanthracenes. The following reactions take place ($R = 2$ -cyano-2-propyl; $A =$ anthracene):



In the case of unsubstituted anthracene, two isomeric compounds $R - A - R$ are formed, presumably a *cis* and a *trans* form with respect to the position of the two R groups; further, a dimer of $R - A.$ is obtained. With 9-substituted anthracenes, only a single isomer $R - A - R$, probably the *trans* compound, is formed.

In previous experiments³ we found that the rate of addition of free radicals to unsubstituted polycyclic aromatics closely paralleled the free valence numbers or localization energies corresponding to the site of attack, and it appeared of interest to extend this work to substituted aromatics. Here, the calculation of theoretical quantities is hampered by lack of information regarding the additional parameters to be employed. The above addition reactions were considered a satisfactory basis for a kinetic approach because of the absence of side-reactions; moreover, ultra-violet spectroscopical analysis of the reaction mixtures could be considered possible in view of the benzenoid character of the reaction products $R - A - R$, as the anthracenes absorb at longer wave-lengths and have higher extinction coefficients than the former.

If a large excess of azo compound is used, the concentration of R will be mainly determined by the rate of decomposition of the azo compound and the rate of dimerization of R . (equations a , d).

For steady-state conditions we can derive the approximate equation,

$$\ln \frac{A_0}{A_t} = k_b \left[k_a^{1/2} k_d^{-1/2} \int_0^t (B)^{1/2} dt \right]$$

in which (A_0) and (A_t) are the anthracene concentrations at times zero and t , respectively, and (B) is the concentration of the azonitrile. The term in brackets is independent of the anthracene. Using the same intake of azo compound, the ratios of $\ln(A_0/A_t)$ for various anthracenes after the same time-interval afford relative values for the rate constants of addition, k_b .

The experiments were carried out in methylcyclohexane solution. After thorough degassing, ampoules containing $\frac{1}{2}$ –1 mgm. of the anthracene and 10–30 mgm. of azobisisobutyronitrile in 25 ml. of solvent were sealed under pure nitrogen. A method was developed for accurately determining anthracene concentrations directly in the ampoules by means of ultra-violet spectrophotometry, using standard curves and background corrections at two or three wave-lengths. In runs at 55° C., anthracene concentrations were determined at twelve time-intervals over a period of about 500 hr., in runs at 70° C. after 18 and 64 hr. The half-life of the azo compound is about 47 hr. at 55° C. and 5 hr. at 70° C. Anthracene conversions were in most cases 40–60 per cent.

The ratios of the k_b values appeared to be practically constant, a fact supporting the assumed kinetics. The spectroscopical accuracy of the anthracene determinations was about 2 per cent, which leads to a mean error in the k_b values of about 0.02. Mean deviations from constancy in the k_b ratios were about 0.03; for the unreactive compound 9,10-dimethylanthracene and the highly reactive 9-cyanoanthracene, the results are believed to be reliable to within 0.06 and 0.25 respectively. Mean relative rate constants based on an anthracene value of 2.00 are given in Table 1.

Substituent influences are seen to be generally small, a fact which is in agreement with Coulson's conclusion⁴ that substituents have little influence on free valence numbers or localization energies, particularly when present at other than the *meso*-positions.

Table 1. RELATIVE RATE CONSTANTS FOR FREE RADICAL ADDITION

Anthracene*	Relative rate constants			
	55° C.		70° C.	
	Total	For 10-position†	Total	For 10-position†
Unsubstituted	2.00	1.00	2.00	1.00
2-Methyl	2.00	1.00	—	—
9,10-Dimethyl	0.24	0.12	0.42	0.21
9-Methyl	2.12	2.06	2.16	2.06
9-Ethyl	1.54	1.48	—	—
9-Cl	1.70	1.64	1.72	1.62
9-Br	1.39	1.33	1.38	1.23
9-OCH ₃	2.15	2.09	2.16	2.06
9-CN	4.30	4.24	4.04	3.94

* Synthesized by standard procedures and purified by percolation over silica gel and repeated crystallizations.

† Computed on the assumption that additions at positions carrying a substituent should be very slow. Thus, in 9-methylanthracene the 9-position should be about one-half as active as in 9,10-dimethylanthracene, that is, 0.06 (55° C.) or 0.10 (70° C.). For the other 9-substituted compounds the contributions of the 9-positions were also taken to be 0.06 and 0.10.

Reactivities depend largely on the conjugative effect of the substituents, polar influences being apparently unimportant. The same conclusion was drawn by Hey *et al.*⁵ on the basis of phenylations of benzene derivatives; here, partial rate factors for p -NO₂, p -Cl, p -Br and p -CH₃ were found to be 7.9, 1.2, 1.8 and 1.4 (D. H. Hey, personal communication), respectively. The value for 9-cyanoanthracene is slightly higher than that found earlier for CCl₃ radicals at 90° C. (2.8)⁶.

Steric influences on conjugation appear to affect the reactivities of anthracenes carrying a bulky 9-substituent. Thus, contrary to the small linear cyano group, the methoxy group is prevented from assuming co-planarity with the rings by the 1 and 8 hydrogen atoms⁷; the conjugating effect of the methoxy group is thereby decreased to the level of the methyl group. The low value found for 9-ethylanthracene as compared with that of the 9-methyl derivative indicates that hyperconjugation is less pronounced in the former case; however, since this was to be expected even if the ethyl group were not hindered⁸, our result cannot be considered a convincing proof for steric interference with hyperconjugation in 9-ethylanthracene. The lower value found for 9-bromo- as compared with 9-chloroanthracene is in contrast to the order found for phenylation of benzenes; this may be related to the greater bulkiness of Br as compared with Cl.

The above conclusions are believed to be independent of the assumptions made as regards the contributions of the 9-position, differences between the various total reactivities being appreciable.

The temperature coefficients of the relative reactivities are probably small. Since analogous 10-positions are attacked, it seems plausible to attribute differences in relative reactivities at a given temperature solely to differences in activation energies. This would lead to differences between the values at 55° and 70° C. of only a few per cent; the general trend of data is therefore consistent with this view.

We thank the management of Koninklijke/Shell-Laboratorium, Amsterdam, for permission to publish this communication.

E. FARENHORST
E. C. KOOYMAN

Koninklijke/Shell-Laboratorium,
Amsterdam-N.
Sept. 16.

¹ Bickel, A. F., and Kooyman, E. C., *Rec. Trav. Chim.*, **71**, 1137 (1952).

² Engelsma, J. W., Farenhorst, E., and Kooyman, E. C., *Rec. Trav. Chim.*, [73, 878 (1954)].

³ Kooyman, E. C., and Farenhorst, E., *Nature*, **169**, 159 (1952); *Trans. Farad. Soc.*, **49**, 58 (1953). Roitt, I. M., and Waters, W. A., *J. Chem. Soc.*, 2695 (1952).

⁴ Cf. Coulson, C. A., *J. Chim. Phys.*, **45**, 243 (1948). Greenwood, H. H., *Brit. J. Cancer*, **5**, 441 (1951).

⁵ Hey, D. H., and Williams, G. H., *Disc. Faraday Soc.*, **14**, 216 (1953). Hey, D. H., *et al.*, *J. Chem. Soc.*, 2892 (1951).

⁶ Kooyman, E. C., and Heringa, J. W., *Nature*, **170**, 661 (1952).

⁷ Jones, R. N., *Chem. Rev.*, **32**, 1 (1943); *J. Amer. Chem. Soc.*, **67**, 2127 (1945).

⁸ Baker, J. W., "Hyperconjugation" (Clarendon Press, Oxford, 1952).

Use of 'Dieldrin' to protect Wool against Insect Attack

THE problem of protecting wool from insect attack has received considerable attention in the past. Methods of temporary protection are available using insecticides such as silico-fluorides, DDT and 'Gammexane'; but these are not fast to processes

such as continued washing or dry-cleaning. Several types of chlorinated aromatic sulphonic acids are commercially available which combine with wool from the dye-bath to give a satisfactory permanent result¹. The industrial application of such methods has been limited, due probably to the fact that the amounts required (at least 1 per cent of the weight of wool) can result in a treatment which is considered to be too expensive.

In experiments to ascertain the effectiveness of 'Dieldrin' and 'Aldrin' for these purposes, it has been observed that 'Dieldrin' in low concentrations is a most effective mothproofing agent, producing a result which is unexpectedly fast to both washing and dry-cleaning.

Samples of worsted fabric (4 gm.) were treated with petroleum ether solutions of each insecticide, the amount applied being regulated by the weight of solution taken up by the sample. After each treatment, the solvent was removed by evaporation at room temperature. To assess washing fastness, each sample was washed in a wash-wheel using 120 ml. of 0.2 per cent soap solution at 45° C., the solution being renewed every 15 min. To determine the effect of dry-cleaning, a sample was placed in a jar with 120 ml. white spirit and rotated for the required time, the solvent being renewed every 15 min.

The effectiveness of each treatment against clothes moth (*Tineola bisselliella*) was evaluated by exposing each of four samples of the various fabrics to ten larvae for a period of fourteen days and observing loss in weight of fabric and mortality of larvae.

The results, which will be reported in detail elsewhere, show that 0.05 per cent 'Dieldrin' on the weight of wool gives a mothproof effect which persists after 1½ hr. washing and 1 hr. dry-cleaning.

Preliminary experiments indicate that 'Dieldrin' is also very effective against furniture carpet beetle (*Anthrenus flavipes* Le Conte). As application from aqueous suspension gives similar results, the method offers the possibility of a convenient technique for protecting wool against insect attack.

M. LIPSON
R. J. HOPE

Commonwealth Scientific and
Industrial Research Organization,
Wool Textile Research Laboratory,
Geelong, Australia.
Nov. 16.

¹ Clark, *J. Soc. Dyers and Color.*, **59**, 213 (1943). Lauger, *Helv. Chim. Acta*, **27**, 71 (1944).

Tanning of Blowfly Puparia

THE nature of the aromatic component responsible for the tanning of the cuticle of blowfly puparia is not entirely clear. Pryor, Russell and Todd¹ isolated protocatechuic acid from puparia of *Calliphora erythrocephala*, but could not find any phenolic material in *Lucilia caesar*. They used large quantities of insects preserved in sulphur dioxide solution. I have re-investigated the problem on small quantities of fresh material, using paper chromatograms.

With *m*-cresol-acetic acid-water solvent, and developing with ferric chloride, small concentrations of dioxypheylalanine were found in mature larvae of *Calliphora* and *Lucilia*, but no protocatechuic

acid, although by the same method it was possible to demonstrate the presence of protocatechuic acid in fresh oothecae of *Periplaneta* and of 3,4-dihydroxyphenylacetic acid in preserved imagines of *Tenebrio molitor* and *Sitophilus granarius*. Besides dioxypheylalanine, *Calliphora* extracts showed the presence only of two substances giving a colour with ferric chloride; one, pink, at *R_F* 0.54, and another, a brownish-pink, at *R_F* 0.75. Repeating the experiment with butanol-acetic acid-water as solvent, and developing with Ehrlich's reagent, ninhydrin, diazotized sulphanilic acid, and ferric chloride, these spots were shown to be due to kynurenin and 3-oxykynurenin; compared with authentic samples they showed the same *R_F* values, gave the same colours with the various developers, and showed the same fluorescence in ultra-violet light. Both substances are present in relatively high concentration.

A comparison with Levenbook's² findings on the blood of *Gastrophilus intestinalis* suggests that the unknown aromatic amino-acid which he found to be present in high concentration was in fact 3-oxykynurenin. Levenbook suggested that his unknown amino-acid was important for the hardening of the puparium, and the behaviour of 3-oxykynurenin with extract of larval cuticle confirms this. When incubated in a respirometer with cuticle extract at pH 7.0, 3-oxykynurenin absorbs oxygen nearly as fast as an equimolar concentration of catechol under the same conditions.

These preliminary observations suggest that in *Calliphora*, and probably in other insects, there is an alternative method of tanning the cuticle, using aminophenols derived from tryptophan instead of dihydroxyphenols derived from tyrosine. Butenandt *et al.*³ have shown that insect eye pigments, as well as the insectorubins described by Goodwin⁴, are formed by the condensation of two molecules of 3-oxykynurenin; it is tempting to suppose that the formation of these pigments is a byproduct of a mechanism for tanning the cuticle.

I am indebted to Dr. C. E. Dalglish for specimens of kynurenin and 3-oxykynurenin.

M. G. M. PRYOR

Department of Zoology,
Downing College,
Cambridge.
Nov. 27.

¹ Pryor, Russell and Todd, *Nature*, **159**, 399 (1947).

² Levenbook, *Biochem. J.*, **47**, 336 (1950).

³ Butenandt, Schiedt, Bickert and Kornmann, *Liebigs Ann.*, **586**, 217 (1954). Butenandt, Schiedt and Bickert, *Liebigs Ann.*, **588**, 229 (1954).

⁴ Goodwin, *Biol. Rev.*, **27**, 439 (1952).

Cytological Contributions to the Phylogeny and Classification of the Rodent Genus *Gerbillus*

THE Gerbillinae are highly differentiated rodents exhibiting many instances of parallel specializations in external and anatomical features evolved in independent lines. Consequently, the present state of the taxonomy of this group is unsatisfactory. Three years ago we started an extensive study of the chromosome complements in the species occurring in Israel. The comprehensive cytological studies of Matthey^{1,2} enabled us to compare the idiograms of our species with those of others from different parts of the family range.

Table 1

	Origin	2n (male)	Sex chromosomes	No. of meta-centric chromosomes	No. of chromosome arms
Group a <i>Gerbillus gerbillus gerbillus</i> *	Israel (Negev)	43	XY, Y ₂	38-40	81-83
Group b <i>Gerbillus allenbyi</i> Thomas	Israel (coastal plain)	40	XY	40	80
<i>Gerbillus pyramidum</i>	Algeria	40	XY	38	78
<i>Gerbillus pyramidum</i>	Israel (coastal plain)	52	XY	22-24	74-76
<i>Gerbillus pyramidum</i>	Israel (Negev)	66	XY	8-12	74-78
Group c <i>Gerbillus (Dipodillus) nanus</i>	Israel (Negev)	52	XY	10-14	62-66
<i>Gerbillus (Dipodillus) dasyurus</i> Wagner	Israel (various localities)	60	XY	6-8	66-68
Group d <i>Gerbillus calurus</i> Thomas	Israel (Negev)	38	XY	32-36	70-74

* Authors' names are omitted when the populations referred to cannot reasonably be supposed to correspond with the types on which the original description was based.

Table 1, which summarizes some of the karyological characters of the species currently considered to belong to the genus *Gerbillus*, reveals a great diversity in numbers and forms of chromosomes. Nevertheless, the forms studied may be arranged in four groups on the basis of chromosome morphology and evolution.

Group a includes so far only *G. gerbillus gerbillus*. Multiple sex-chromosomes, very probably of the XY, Y₂ type, are readily recognizable as a trivalent in metaphase I (Fig. 2). The male diploid chromosome number is 43 (Fig. 1), whereas a single female examined was found to have almost certainly 42 chromosomes. The large and easily distinguishable X-chromosome is present twice in the female. Although this species has almost the same number of chromosomes and chromosome arms as *G. allenbyi* and *G. pyramidum* (Algeria), its metacentric chromosomes present a striking contrast to those of all other forms studied in being much shorter than the V-shaped elements of the other karyotypes. This unique character, which was observed in all plates, demonstrates clearly the caution required in evaluating the significance of the number of chromosome arms. It appears to us that both the detailed morphology and the gross differences in the size of the elements deserve consideration in comparative studies.

Since within groups b and c there is approximate correspondence in the size of the chromosomes and in the number of their arms, the wide variation in the mitotic numbers must be attributed to Robertsonian changes. Group b comprises four forms. The first is endemic to Israel and currently considered as the subspecies *allenbyi* of *G. gerbillus* Olivier². There is no doubt that *G. allenbyi* shares the main karyo-

logical characteristics of the three other members of this group while presenting none of the cytological features described above for *G. gerbillus*. It must be concluded, therefore, that it can no longer be regarded as conspecific with *G. gerbillus*. We propose to restore the original author's name *G. allenbyi* Thomas 1918. The other three forms of this group, each of different geographical origin, have been provisionally designated as *G. pyramidum*, since for the present they can only be distinguished by their cytological characteristics. Dr. T. C. S. Morrison-Scott (personal communication), who kindly examined a few specimens from the three populations, came to the conclusion that those differences that "exist between the six specimens submitted are not such as would justify nomenclatural differentiation according to the normal criteria used in taxonomy. I should not have called them different races". It should be noted that *G. pyramidum* is sympatric with *G. allenbyi* in the coastal plain. We believe, therefore, the latter to be specifically different from the *pyramidum* complex in Israel. *G. pyramidum* from the Negev, the southern semi-desert of Israel, is of particular interest since it exhibits a chromosomal polymorphism the study of which is now in progress. Apart from the individuals possessing 33 bivalents, other specimens from the same locality were found to have only 31 autosomal elements in the first meiotic metaphase, one of them rather asymmetrical. This would seem to be the first record of an intrapopulational chromosomal polymorphism in mammals. Matthey's observation^{1,4} of a multiple sex mechanism in *G. pyramidum* from Algeria could not be confirmed in the three Algerian specimens examined by us.

Group c includes *G. nanus* and *G. dasyurus*, which are very similar externally. Earlier taxonomists referred these species to the genus *Dipodillus*. Modern authorities considered the characters used for this separation to be of secondary value and therefore assigned only subgeneric rank to the *Dipodillus* group⁵. The cytological evidence favours the separate status of these species, since they are different from the other groups in chromosome size and number of arms. Like group b, they show a Robertsonian relationship among themselves. *G. campestris*, 2n = 56, studied by Matthey¹, cannot be fully compared with the above species because no mitotic plates are figured. But the similarity in the aspect of the first metaphase plates would seem to confirm the affinity of this form to the *Dipodillus* group^{3,5}. *G. nanus* (2n = 52) has a distinct sex bivalent, whereas the sex chromosomes could not be identified in *G. garamantis* (2n = 54)².

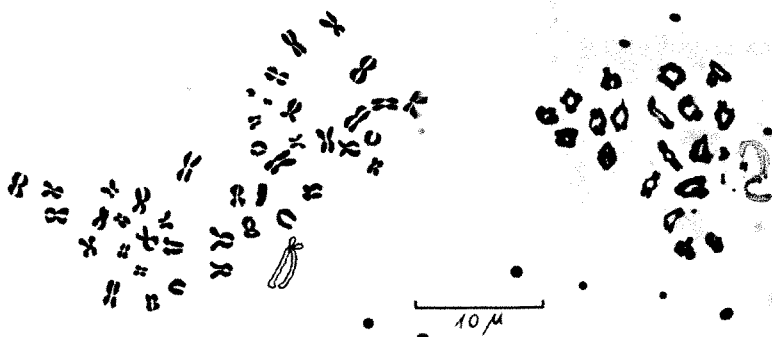


Fig. 1

Fig. 2

Gerbillus gerbillus gerbillus. Acetic-orcein squashes after hypotonic pretreatment. Camera lucida drawings. $\times 1,650$. Fig. 1. Spermatogonial metaphase; chromosome X₂ outlined. Fig. 2. Metaphase I; sex trivalent supplied.

considered to be another race of the same species³.

G. calurus (group *d*) has been assigned to the genus *Meriones*, although originally described as *Gerbillus calurus*³. Recently, it was referred once again to the subgenus *Dipodillus* by Wassif⁶ on morphological evidence. The cytological picture does not warrant the inclusion of this species in the *Dipodillus* group. The mitotic plate somewhat resembles that of group *b*. However, cytological characteristics alone do not seem to suffice at the present stage to justify the establishment of a novel taxonomic grouping.

On the other hand, the findings reported here—which will be presented in full elsewhere—suggest that by applying comparative cytological methods it is possible to split artificial assemblages of forms. Moreover, in view of the cytological heterogeneity already recorded, we hope that a wide-scale study of the numerous gerbils known will contribute materially to the natural classification of this family.

The technique of pre-fixation treatment with diluted Tyrode solution was mentioned in an earlier note⁷. Excellent results are also obtained by the use of 0.3–0.5 per cent sodium chloride solutions. Three to seven males of each species were analysed.

We thank Dr. E. Goldschmidt for her interest in this work. We are indebted to Dr. T. C. S. Morrison-Scott for the identification of several specimens and to Dr. F. Petter for gerbils from Algeria. The animals used in this study were collected by Dr. H. Mendelssohn, Mr. M. Costa and ourselves during a survey of the rodents of Israel.

J. WAHRMAN
A. ZAHAVI

Department of Zoology,
The Hebrew University,
Jerusalem.
Nov. 19.

¹ Matthey, R., *Rev. suisse Zool.*, 60, 225 (1953).

² Matthey, R., *Caryologia*, 6, 1 (1954).

³ Ellerman, J. R., and Morrison-Scott, T. C. S., "Checklist of Palaearctic and Indian Mammals 1758 to 1946" (British Museum, London, 1951).

⁴ Matthey, R., *Arch. Klaus-Stift. VererbForsch.*, 27, 163 (1952).

⁵ Ellerman, J. R., "The Families and Genera of Living Rodents", vol. 2 (British Museum, London, 1941).

⁶ Wassif, K., *J. Mammal.*, 35, 243 (1954).

⁷ Wahrman, J., and Zahavi, A., *Bull. Res. Council. Israel*, 3, 265 (1953).

Influence of Impurities on the Growth of Quartz Crystals from Flint and Quartzite

HITHERTO the most successful methods^{1,2} of growing large quartz crystals have employed a hydrothermal technique in which melting-quality quartz is used as the source material for maintaining the supersaturation of the liquid with respect to silica in the vicinity of the growing crystals. We have now found means whereby the melting-quality quartz can be replaced satisfactorily by other mineral substances rich in silica, such as flint and quartzite. These materials have the advantage of ready availability in the United Kingdom.

When flint, a cryptocrystalline variety of quartz, is used in place of melting-quality quartz without any other changes in the procedure previously described², the resulting crystals show minor but

distinct changes in habit and a serious worsening of crystalline quality. However, we find that when the usual aqueous solution of sodium carbonate is modified by the addition of certain proportions of sodium hydroxide and sodium fluoride³, crystals are obtained which are similar in quality and habit to those grown from melting-quality quartz.

Quartzites, as source materials, fall into two main classes. Class *A* behave much the same as melting-quality quartz, whereas class *B* require the modified solution referred to above. Considerable experimental evidence has been obtained to indicate that this difference is associated with the nature of the felspar which is commonly present as a minor constituent of the quartzite. Moreover, a preliminary investigation has shown that the poorer quality obtained from flint and class *B* quartzites, when crystals are grown in a sodium carbonate solution, is due to the incorporation of aluminium into the structure of the growing crystals. The evidence for this is provided by spectrographic tests, paramagnetic resonance experiments⁴, and the study of the darkening brought about by X-ray irradiation of sections cut from crystals. In addition, the direct test has been made of deliberately adding aluminium in a number of forms to the solution when growing from pure melting-quality quartz. It is found that, in the presence of this aluminium, the system behaves as if flint or class *B* quartzites were being used, and the reversion to normal good quality is brought about by the use of the modified solution. This is illustrated by Fig. 1, in which the small experimental crystals shown were grown under the following conditions:

Source material	Solution	
(a) Flint	Sodium carbonate	
(b) Melting-quality quartz + aluminium	"	"
(c) Melting-quality quartz	"	"
(d) Melting-quality quartz + aluminium	" + sodium hydroxide + sodium fluoride	"

Although not illustrated, the crystals obtained from class *B* quartzites in sodium carbonate solution are similar to that shown in Fig. 1(a). In the same way, Fig. 1(d) is typical also of the crystals obtained from flint and class *B* quartzites using the modified solution. The feature of these crystals which is most readily apparent from the photographs is the nature of the upper surface, approximating to (0001), on which most growth takes place. The pronounced pitting of this surface in Figs. 1(a) and (b) should be contrasted with its smoothness in Figs. 1(c) and (d).

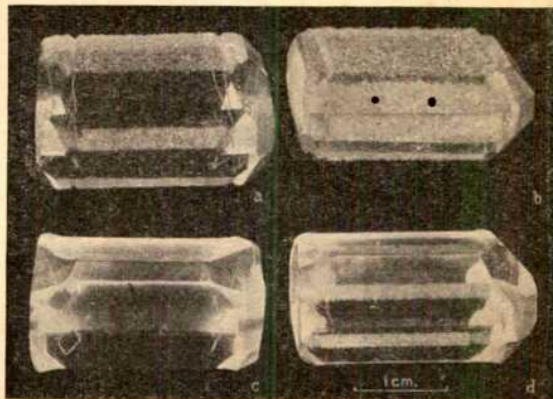


Fig. 1

It has been observed that the pitted crystals tend to develop cracks during their growth, and examination shows that they are in a state of strain.

The results obtained from flint and class B quartzites can be explained by the presence of small amounts of aluminium in the mineral which become available for incorporation in the growing crystal. In the quartzites, this aluminium will generally originate from the feldspar in the rock. The most important feature requiring explanation is the difference between class A and class B quartzites. It is believed that this difference lies in the behaviour of various feldspars under the hydrothermal conditions. In general, we have found that the aluminium present in the triclinic feldspar minerals is bonded in the structure in such a way that the aluminium does not become available in solution in a form that results in its incorporation into the growing crystal. These are the feldspars present in the class A quartzites. In contrast, the monoclinic feldspars, in particular orthoclase in its various forms, break down so that the aluminium does become incorporated. This latter type of feldspar is considered to be responsible for the behaviour of at least some of the class B quartzites. It appears probable that the behaviour of the two classes of feldspars is related to the degree of ordering of the aluminium and silicon atoms in the crystal lattice, the aluminium in the disordered structures going into solution in a form which can be taken up in the growing crystal.

We acknowledge the advice and encouragement of Mr. J. W. Ryde throughout the course of this investigation. We are also indebted to Dr. W. H. Taylor for a helpful discussion regarding the feldspar problem, and to Dr. J. H. E. Griffiths and his collaborators for information on paramagnetic resonance behaviour.

C. S. BROWN
R. C. KELL
P. MIDDLETON
L. A. THOMAS

Research Laboratories,
The General Electric Co., Ltd.,
Wembley, Middlesex.
Nov. 8.

¹ Walker, A. C., *et al.*, *Indust. and Eng. Chem.*, **42**, 1369 (1950); **48**, 1670 (1954).

² Brown, C. S., *et al.*, *Min. Mag.*, **29**, 858 (1952); *Acta Cryst.*, **7**, 668 (1954).

³ British Patent Applications Nos. 13753/53, May 15, 1953; 27169/53, Oct. 2, 1953.

⁴ Griffiths, J. H. E., *et al.*, *Nature*, **173**, 439 (1954)

Dielectric Properties of Pinacol Hydrate: Application to Temperature Measurement

In the course of research into the dielectric properties of hydrogen-bonded structures, the dielectric properties of pinacol hexahydrate $\{(\text{CH}_3)_2\text{C}(\text{OH})\cdot\text{C}(\text{OH})\cdot(\text{CH}_3)_2\cdot 6\text{H}_2\text{O}\}$ were measured. It was found that in this compound a region of dielectric dispersion occurs centred about a frequency of 80 kc./s. at a temperature of 20° C. For polycrystalline material the relative permittivity falls from 45 to 3 in this dispersion region. The mid-frequency of this dispersion varies rapidly with temperature (Fig. 1) and can be described by the following expression: $f = 2 \times 10^{17} \exp(-H/kT) \text{ sec.}^{-1}$, where H is 16.5 k.cal./mol. In the vicinity of 20° C.

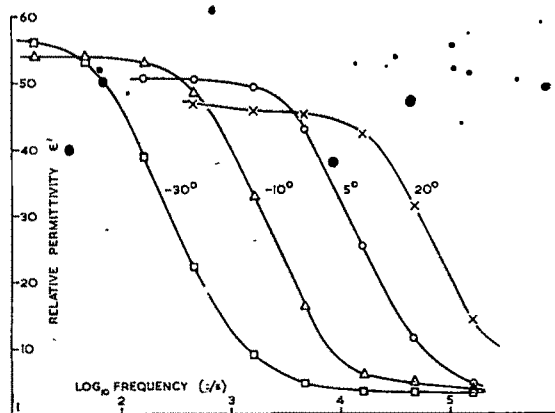


Fig. 1. Dielectric dispersion of pinacol hexahydrate at various temperatures

this means that the centre frequency of the dispersion region has a temperature coefficient $\left(\frac{df/dT}{f}\right)$ of 9 per cent per deg. C., and, if measuring at a fixed frequency near the centre, the variation in permittivity is 5.5 per cent per deg. C. The resistance of semiconducting material used in thermistors varies at the rate of 1.5–5 per cent per deg. C. at about room temperature¹. Consequently it would appear that a capacitor made with pinacol hydrate as dielectric could have applications as the thermal-sensitive element in circuits used for the measurement or control of temperature.

There is, of course, dielectric absorption associated with this dispersion, with a maximum dielectric loss factor of 17 corresponding to a $\tan \delta$ of approximately 0.75 at the centre of the dispersion region. However, in any application based on the rate of change of permittivity with temperature, provided the centre of the dispersion region is used, the change in dielectric loss factor will be small, since the absorption has a flat maximum in this region.

It should be mentioned that any capacitor constructed with pinacol hydrate would need to be sealed, since this compound loses moisture slowly on exposure to the atmosphere (approximately 20° C. and 60 per cent relative humidity) and reverts to pinacol.

A more complete discussion of the dielectric properties of this compound is in preparation.

J. S. DRYDEN
R. J. MEAKINS

Division of Electrotechnology,
National Standards Laboratory,
Commonwealth Scientific and
Industrial Research Organization,
Australia.
Dec. 3.

¹ Becker, J. A. Green, C. B., and Pearson, S. L., *Elec. Eng.*, **65**, 711 (1946); Standard Telephones and Cables Pty., Ltd., "Thermistors".

Pulsation and Mass Transfer of Pendent Liquid Droplets

Lewis and Pratt¹ observed that pendent drops containing solute which diffuses into the surrounding continuous phase sometimes showed ripples and pulsations at the interface; this was associated with increased rates of mass transfer. We have observed

similar behaviour with pendent drops of nitrobenzene, chlorobenzene, carbon tetrachloride and chloroform containing, as solutes, acetone, ethyl alcohol, methyl alcohol and isopropyl alcohol. The concentration of solute varied between 2 and 30 per cent.

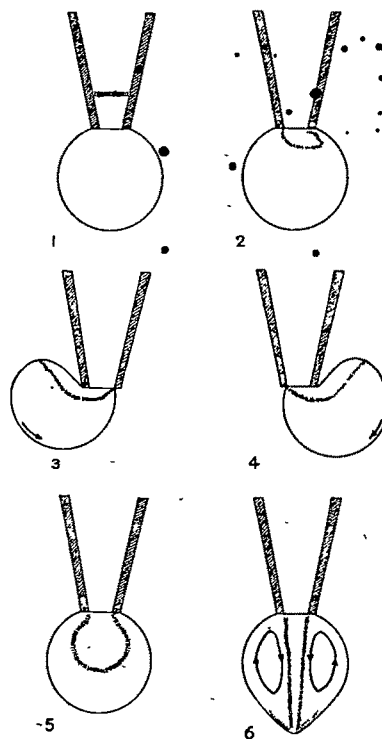
Drops were formed at the capillary end of a 25-ml. pipette. The rate of drop formation was controlled by regulating the flow of air into the pipette. Distilled water was used as the continuous phase, and the drops were formed at approximately 1 in. below the surface of the water. With the aid of suitable illumination and a visual reference system comprising a fine wire gauze behind the glass column containing the water, changes of refractive index, and thus the concentration gradients, both within and around the drops could be observed. Fine aluminium powder was suspended in the drop fluid so that any motion in the drops and also in the capillary could be seen.

There were marked differences in the pulsating behaviour and the type of motion within the drops, and these depended on: (a) rate of flow of the fluid into the drops (rate of drop formation); (b) concentration of solute; (c) nature of the liquids.

Very slow rates of drop formation (1–2 drops per min.). In the early stages of drop growth, the fluid near or at the water-drop interface revolved rapidly around the vertical axis of the capillary. After the drop had grown to approximately one-quarter of its maximum size, intermittent pulsations and rotation about a horizontal axis occurred, during which most of the solute diffused out of the drop. Between the pulsations the drop became motionless and there was no visible diffusion. Fig. 1 shows the drop when no pulsation or rotation is taking place. Fig. 2 shows the condition immediately before the start of pulsation. The shaded part in these diagrams represents a zone of sharp concentration gradient (often a cloudy layer) between the original liquid containing high concentration of solute and the drop fluid which has been depleted of most of its solute. The pulsation of the droplet and the rotation within the drop occurred only when this layer was within the drop.

Slow rates of drop formation (2–10 drops per min.). At slightly faster rates of formation, the period spent in the quiescent state diminished and the zone of concentration gradient was within the drop but near the end of the capillary (Fig. 2). It had a hemispherical or irregular shape and moved at random from side to side. Whenever the zone approached the drop-water interface a marked distortion of the shape of the drop rapidly developed (Figs. 3 and 4). Simultaneously rapid rotation around a horizontal axis (in clockwise or anti-clockwise direction) commenced within the drop, followed by a marked increase in the rate of mass transfer, mainly at the distorted part of the drop surface.

The direction of rotation was found to depend on the position of the zone of concentration gradient in relation to the drop-water interface. Fig. 3 shows a drop in which the zone has moved to the left-hand side and the direction of rotation is now anti-clockwise; Fig. 4 shows the rotation taking place in clockwise manner with the zone of concentration gradient on the right-hand side. With the depletion of solute at the small zone of high concentration (area above the line of shading), the interfacial tension around the whole of the surface becomes more uniform and the drop tends to resume its normal



position and shape. If this occurs rapidly, the drop overshoots to the opposite direction (from the position of Fig. 3 to that of Fig. 4). The hemispherical zone of high concentration now moves to the opposite side and the process is repeated, and results in a regular and continuous pulsation.

Medium rates of drop formation (10–30 drops per min.). The zone is now forced farther into the droplet and acquires an approximately spherical shape (Fig. 5). Diffusion takes place uniformly all around the drop surface. The surface zone of the drop is in continuous, irregular motion; but the shape of the droplet remains unaltered.

High rates of drop formation (30–45 drops per min.). The zone of concentration gradient takes the shape of a thin jet inside the drop (Fig. 6). There is a notable decrease in the radius of curvature of the surface at the lowest point in the drop and circulation occurs in the form of a vortex ring inside the drop. Diffusion mainly occurs near the pointed end where the solute concentration is highest.

At low concentrations of solute (1–5 per cent) the distortion of the drop shape, the pulsation and the motion within the drops were always much less than for higher concentrations.

Pulsation and circulation behaviour varied with the nature of both the solute and the solvent. For example, drops of 10 per cent ethyl alcohol and 90 per cent chlorobenzene showed a much more vigorous pulsation than drops of chlorobenzene with 10 per cent acetone as solute. Chlorobenzene solutions exhibited the phenomena more intensely than similar solutions of nitrobenzene. Chloroform and carbon tetrachloride systems showed much less pulsation and rotation.

The presence of small amounts of a surface-active compound in the aqueous phase (for example, 0.01 gm. sodium dodecyl sulphate in 1 lit. of distilled water) suppressed these phenomena. There was also

no visible diffusion of solute into the continuous phase for drops containing up to 10 per cent solute.

F. H. GARNER

C. W. NUTT

M. F. MOHTADI

Department of Chemical Engineering,
University of Birmingham. Dec. 10.

¹ *Nature*, 171, 1155 (1953).

Age of Uraninites from Crystallographic Data

IN a recent communication, Wasserstein¹ has suggested a new method of age determinations on uraninites by means of X-ray techniques. This thesis is that radioactive decay results in the replacement of the tetravalent uranium ion by the smaller lead ion, the calculated shrinkage in cube edge due to this process being approximately 0.004 Å. per hundred million years. Wasserstein classifies uraninites into three groups: γ (U_4O_7 type), α (UO_2 type) and β (U_3O_8 type), and suggests that thorianites, which resemble γ -uraninites in their properties, may have Th_4O_7 as their prototype.

We are of the opinion that this picture has been over-simplified and is not consistent with the known chemistry of the uranium oxides. In addition to the radioactive decay which tends to shrink the cube edge below that of pure uranium oxide, and the presence of thorium which serves to expand the lattice parameters, several other factors should be taken into consideration. Specifically these are: oxidation due to weathering, and radiation damage. As Wasserstein points out, oxidation of UO_2 to β - U_3O_8 results in a decrease in cube edge from 5.470 Å. to 5.440 Å. Every uraninite specimen for which an analysis has been reported has been shown to be oxidized to some extent; some are altered sufficiently so that ignition in vacuum or an inert atmosphere converts them partially or even completely to U_3O_8 , and this oxidation should be reflected in the lattice parameter. In this regard, Wasserstein's classification of γ -uraninites as U_4O_7 types is questionable. The existence of U_4O_7 itself is based only on X-ray evidence² (an increase in cube edge above that of UO_2), and has as yet not been substantiated by chemical analyses. Assuming that U_4O_7 actually has been prepared, which is doubtful, the method of preparation in each case has involved extreme reducing conditions (that is, ignitions of mixtures of uranium oxide with uranium metal) which are not likely to be encountered in Nature. Extrapolation of this line of reasoning to suggest the existence of Th_4O_7 is, we believe, on even more doubtful ground since no experimental evidence exists for such a compound. Rather this phenomenon (contraction of the cube edge on ignition) in thorianite should suggest seeking an alternative explanation. It has been shown that radiation damage in a number of substances, including zircon, diamond, silicon carbide and quartz, results in an increase in lattice dimensions³. It would seem more reasonable to us to ascribe the γ -type ores to radiation damage than to reduction of uranium and thorium below the tetravalent state.

To the list of factors influencing lattice dimensions in uraninites should also be added the presence of rare-earth and alkaline-earth oxides, since these have been shown to form ternary fluorite-type oxides with

uranium over a considerable oxygen to metal ion ratio range⁴.

We feel that all these factors will play a significant part in determining uraninite lattice dimensions, thus making an age calculation based on Wasserstein's proposal of doubtful value.

HENRY R. HOEKSTRA
JOSEPH J. KATZ

Chemistry Division,
Argonne National Laboratory,
Lemont, Illinois.

¹ Wasserstein, B., *Nature*, 174, 1004 (1954).

² Zachariasen, W., MP Chicago Report N-1973 (1945) Rundle, R. E., et al., *J. Amer. Chem. Soc.*, 70, 103 (1948). Hering, H., and Perio, P., *Bull. Soc. Chem. France*, 352 (1952).

³ Hurley, P. M., and Fairbairn, H. W., *Bull. Geol. Soc. Amer.*, 64, 666 (1953). Primak, V., et al., *Phys. Rev.*, 92, 1064 (1953).

⁴ See, Seaborg, G. T., and Katz, J. J., "The Actinide Elements", NNES, Div. IV, 1A, 144, 176.

THE criticism offered by Drs. Hoekstra and Katz is relevant in stressing certain chemical difficulties which may defy solution by conventional analyses—mineral chemists know such problems too well, for example, the role of iron in many minerals. They rely on chemical analyses of uraninites for their views; but I am suspicious of such analyses as they still report lead as PbO , when that of radiogenic origin should be PbO_2 ; that due to, say, galena, would be correctly given as PbO . Such duality exists in the position of oxygen, too, as it takes a double role crystallographically in many uraninites—such data cannot adequately be determined chemically.

There must be grave doubts that the proportion of different uranium oxides, such as UO_3 and U_3O_8 , are in fact present as such in uraninites. Controversy is still rife among chemists in this very field of uranium oxides. How then can Drs. Hoekstra and Katz state that my thesis "... is not consistent with the known chemistry of the uranium oxides"? The operative word is, I suggest, "known". I agree that, in the interests of clarity, I have simplified my concepts, but I trust I have not done this to a fault.

The essential points of the criticism, which carried no surprises, can be answered as follows:

(1) *Existence of U_4O_7 and Th_4O_7 .* Actually these compounds are not essential for my thesis. At this stage it may be advisable to write γ -uraninite as $UO_{2.5}$. As experimental evidence indicates that oxidation is necessary to obtain the cube-edge of the corresponding α -type from the γ -type, an analogue of a lower oxide than UO_2 exists: Zachariasen's U_4O_7 is the closest laboratory counterpart. That the laboratory method of its preparation does not duplicate the conditions under which γ -type is formed in Nature is no criterion for the belief in the existence of the mineral or not.

All γ -uraninites are characterized by the presence of the large thorium ion; pitchblendes carry virtually none of it, but may contain such small ions as those of zirconium and titanium (for example, in Colorado). These replacements of uranium are in accordance with the principle that lower valence of an element is indicative of larger ionic size, and conversely. The different 'valences' envisaged in my classification must have influenced the nature of the replacements at the time of the formation of the minerals. Such observations stress the individuality of the γ -type.

The fact that Th_4S_7 is known suggests that Th_4O_7 is possible; my statement that " U_4O_7 may be a separate compound analogous to Th_4S_7 " was a

quotation in the text-book of which one of my critics is a co-author.

(2) *Weathering and oxidation.* Obviously highly weathered samples do not lend themselves to age determinations—they may not qualify even as uraninites. Sample selection largely obviates such difficulties, especially when the minuteness of the material required for X-ray determinations is considered. Heat treatment, particularly as used for γ -types, further helps to limit, and also recognize, this factor. The effect of oxidation should not be over-emphasized, as in some samples the effect on the parameter proved less than the error in determination.

The material used for the tabulated results is above reproach.

(3) *Radiation damage.* This is a negligible factor here, except perhaps in comparatively young pitch-blendes. To try to explain γ -uraninites by increase in lattice parameter brought about by radiation immediately poses the question of the other two types: Why are these not similarly affected? The suggestion cannot explain the chemical differences observed.

(4) *Presence of rare-earths and alkaline-earths.* Sample selection by the avoidance of nivenites and cleveites controlled the effect of the omnipresence of the rare-earths. These elements generally depress the parameter but, in the samples used, such reduction is negligible. The role, if any, of the alkaline-earths is inconsequential here.

I thank Drs. Hoekstra and Katz for their criticism, but it has offered no explanation of the regularity observed in my table of results; they infer that results may show haphazard values. If cube-edges of uraninites are considered in the light of my thesis, a fine order is found to exist where chaos now reigns.

B. WASSERSTEIN

Geological Survey, Pretoria.

Age of the Mineralization of the Witwatersrand

Louw¹ has recently reported new isotopic assays of radiogenic lead from the uraninites of the Witwatersrand, and has utilized these data in arguments supporting a placer origin for the Rand mineralization. The same information has been published in fuller extent elsewhere², and a third paper by the same author, already circulated in preprint form, is in the press³.

These arguments based upon mass-spectrographic analyses form the sole response of South African scientists to the criticisms of the placer theory which I have published in recent years⁴. A refutation of Louw's conclusions awaits printing elsewhere⁵; and since repetitive publication is to be deprecated, it will suffice to note here that much of the latest South African work is vitiated by the lack of mineragraphic control of the uraninite samples studied, which were greatly contaminated by galena of unknown isotopic composition. Restricting attention to measurements on the less impure samples carrying upwards of about 50 per cent uranium, there are now nine ²⁰⁷Pb: ²⁰⁶Pb ages available for Witwatersrand uraninite, determined by four different laboratories. These ages uniformly fall within the average of $2,055 \pm 150$ million years, a result in good agreement with the dating of $2,080 \pm 40$ million years arrived at by Holmes⁶ for the Limpopo granitization nearby. Age determinations therefore lend support to the already

weighty arguments favouring an epigenetic origin for the Rand ores by pointing, for the first time, to a cycle of granitization, with which the mineralization may be connected.

C. F. DAVIDSON

Geological Survey and Museum,
London, S.W.7.
Feb. 21.

¹ Louw, J. D., *Nature*, 175, 349 (1955).

² Louw, J. D., *S. African Min. Eng. J.*, 85, 621 (1954).

³ Louw, J. D., *Trans. Geol. Soc. S. Africa*, 57 (1955).

⁴ Davidson, C. F., and Bowie, S. H. U., *Bull. Geol. Surv.*, 3, 1 (1951).

Davidson, C. F., *Mining Mag.*, 88, 73 (1953).

⁵ Davidson, C. F., *Mining Mag.*, [92, 152 (1955)].

⁶ Holmes, A., *Col. Geol. Min. Res.*, 5, 3 (1955).

A New Joule Manuscript

IN 1851, William Hopkins, of Cambridge, obtained a grant of £250 from the Government "for investigations on the effect of pressure on the temperature of fusion of certain substances". It was stipulated that expenditure of the money should be under the control of a committee which included Joule.

During the next few years Hopkins, Joule and William Fairbairn worked in close co-operation on these problems, and Hopkins reported some of their findings (which were not recorded) to the Hull meeting of the British Association in September 1853. This report would certainly include results given in a letter, written by Joule, and recently found in a volume of Watts's translation of "Gmelin's Hand-Book of Chemistry" (which once belonged to Joule and is now in the Manchester College of Technology Library). Joule gives details of a series of experiments he did on the physical properties of beeswax "which may perhaps serve to throw some light on the alteration of the point of liquefaction by pressure".

It is addressed to William Hopkins from Acton Square, Salford, and is dated August 20, 1853. It would appear to be a draft, because in a letter dated August 24 to Fairbairn¹ giving him only a brief outline of the results, Joule says: "I transmitted to Mr. Hopkins yesterday . . .", that is, three days later than the date on the letter recently found.

There are twelve small pages, and the first eight give details of nine experiments carried out to determine the specific heat of wax at differing temperatures and the heat absorbed in changing the state of one grain of wax from perfect solidity to perfect fluidity. Joule remarks: "having no exact point at which perfect solidity is followed by perfect fluidity, our 'stationary point' (Hopkins's term) was entirely delusive". The remaining four pages are devoted to the expansion by heat of beeswax, in which Joule uses a formula of William Thomson. He finishes by saying: "the experiments which I have related are worth repeating and with greater accuracy. This, however, would require apparatus for the purpose and more time than I shall have at my disposal for some weeks to come. I hope, however, that the above results, such as they are, will not be without their use in formulating your views".

The letter may be seen in the College of Technology Library, Manchester.

L. L. ARDERN

College of Technology,
Manchester. Feb. 11.

¹ Pole, William, "Life of Sir William Fairbairn", 296 (1877).

FORTHCOMING EVENTS

Monday, April 4

BRITISH OCCUPATIONAL HYGIENE SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Discussion on "The Assessment of Health and Disease in Industry".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. R. D. Hayes: "Cambridge Expedition to Ancora (North Portugal)".

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. S. G. Lankester and Mr. W. D. Wallace: "Some Investigations into Singing Propellers".

Monday, April 4—Tuesday, April 5

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (in the William Beveridge Hall, Senate House, University of London, W.C.1), at 9.30 a.m. daily—Symposium on "The Prevention of Atmospheric and Water Pollution in the Chemical Industry".

Monday, April 4—Wednesday, April 6

FARADAY SOCIETY (in the Department of Zoology, Cambridge University)—General discussion on "Microwave and Radio-Frequency Spectroscopy".

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1)—Spring Meeting.

Wednesday, April 6

At 10.15 a.m.—Annual General Meeting.

Tuesday, April 5

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS AND RADIO SECTIONS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. D. M. MacKay: "High Speed Electronic-Analogue Computing Techniques".

Wednesday, April 6

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. Dirk Brouwer: "Motions of the Outer Planets" (George Darwin Lecture).

ZOOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers and Films.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. F. Moxon: "Regional Problems in the Provision and Maintenance of V.H.F., U.H.F., and S.H.F. Radio Links".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Allergy: Current Conceptions". Chairman: Sir Henry H. Dale, O.M., F.R.S.: Speakers: Dr. Bernard N. Halpern, Prof. J. R. Marrack and Dr. J. Pepys.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B (with a degree or equivalent qualification) IN INORGANIC CHEMISTRY—The Principal, Slough College for Further Education, William Street, Slough (April 9).

CHEMIST (with a degree in chemistry or equivalent qualifications and a sound knowledge of modern instrument techniques, and with experience in investigational and research work, and ability to lead a small research group), at the Central Laboratory, Shade House, Pendlebury, Manchester—The Establishment Office, National Coal Board, 40 Portland Street, Manchester 1 (April 9).

LECTURER (with an honours degree and also appropriate qualifications in agriculture, and with experience of research and teaching in field experimentation) IN FIELD EXPERIMENTATION—The Secretary, School of Agriculture, University of Cambridge, Downing Street, Cambridge (April 13).

ASSISTANT, Grade B (with a degree or equivalent qualification in mining or geology, and preferably with practical experience in the coal mining industry) IN THE DEPARTMENT OF MINING, to teach geology to general certificate of education advanced level and to higher national certificate standard in the mining and mine surveying courses—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (April 14).

LECTURER, Grade I, or LECTURER, Grade II, IN AGRICULTURAL ECONOMICS AND FARM MANAGEMENT, and an ASSISTANT LECTURER IN ANIMAL HUSBANDRY, at the University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (April 15).

ASSISTANTS IN MATHEMATICS—Secretary of University Court, The University, Glasgow (April 16).

CHEMIST, Senior Scientific Officer grade (with an honours degree or equivalent, and postgraduate research experience in physical chemistry, preferably on the properties of surfaces or of high polymers), at a Ministry of Supply Research Establishment near Salisbury, Wilts,

to take charge of a small team undertaking research on permanently biofouling coatings—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.173/5A (April 16).

READER or SENIOR LECTURER IN CHEMISTRY, and LECTURERS or ASSISTANT LECTURERS (2) IN CHEMISTRY, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 21).

CHAIR OF AGRICULTURE at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 23).

VETERINARY BACTERIOLOGIST, Senior Research Officer or Research Officer grade (with a university degree in veterinary science, with postgraduate research experience in bacteriology or immunology, or equivalent qualifications) IN THE ANIMAL HEALTH RESEARCH LABORATORY, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, Australia, to undertake research work on aspects of bovine contagious pleuropneumonia—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 201/74 (April 23).

ASSISTANT LECTURER (with an honours degree in geology and an interest in palaeontology and Palaeozoic stratigraphy) IN GEOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (April 25).

LECTURER (with special experience of X-ray crystallography) IN CHEMICAL PHYSICS OF SOLIDS in the Department of Chemical Engineering—Head of the Department of Chemical Engineering, Imperial College, London, S.W.7 (April 25).

CHAIR OF PHYSICAL METALLURGY—The Registrar, University College, Singleton Park, Swansea (April 30).

CHAIR OF VETERINARY PATHOLOGY—The Registrar, The University, Liverpool (April 30).

JUNIOR FELLOW (preferably with research experience in fluid mechanics) IN APPLIED MATHEMATICS—The Registrar and Secretary, The University, Bristol (April 30).

LECTURER IN PHYSICS, at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, April 30).

LECTURER IN PSYCHOLOGY; a LECTURER IN METAL PHYSICS, and a LECTURER (with special interests in fluid mechanics) IN ENGINEERING—The Registrar, University College, Singleton Park, Swansea (April 30).

LEICESTER LOVELL RESEARCH STUDENT, to study the mechanism and kinetics of reactions of epoxides—Professor of Chemistry, The University, Southampton (April 30).

ASSISTANT CURATOR (with an honours degree in some branch of natural science including zoology, and preferably with museum experience) OF INVERTEBRATES in the Museum of Zoology—Dr. A. S. Watt, Botany Department, University of Cambridge, Downing Street, Cambridge (May 1).

ASSISTANT LECTURER IN PHYSICS—The Registrar, University College of North Staffordshire, Keele, Staffs (May 1).

ENGLISH ELECTRIC RESEARCH FELLOW IN AERONAUTICS—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks (May 1).

LECTURER IN ASIAN ANTHROPOLOGY—The Secretary, School of Oriental and African Studies, University of London, W.C.1 (May 1).

LECTURER (medical qualification not essential) IN THE DEPARTMENT OF BACTERIOLOGY—The Registrar, The University, Liverpool (May 1).

CHAIR OF PARASITOLOGY tenable at the Imperial College of Science and Technology, London, S.W.7—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 3).

READER IN GEOLOGY at King's College, Strand, London, W.C.2—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 5).

RESEARCH OFFICER (Rheologist) (with a university honours degree in science, with physics and/or chemistry as a major subject or equivalent qualifications) IN THE DIVISION OF BUILDING RESEARCH, Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, Australia, for investigations into the rheological characteristics of building materials—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 390/204 (May 21).

ELLISON RESEARCH FELLOWS (graduates of British universities) IN CHEMISTRY or PHYSICS; and a RESEARCH SCHOLAR for research work connected with the chemistry of amino-acids, peptides and proteins—The Registrar, The University, Sheffield (June 1).

ROYAL DUTCH SHELL STUDENT IN GEOPHYSICS—The Registrar, Imperial College of Science and Technology, London, S.W.7 (June 1).

ASSISTANT LECTURER IN INORGANIC CHEMISTRY—Prof. Barrer, Chemistry Department, Imperial College, London, S.W.7.

BIOCHEMIST, Basic grade (with a science degree or A.R.C.S. diploma)—The Group Secretary, Walsall General Hospital, Walsall, Staffs.

LABORATORY TECHNICIAN (preferably with a knowledge of photography), to assist in the care of animals and in biological experiments, and to prepare specimens for microscopical examination—The Director, B.E.C.C. Research Unit in Radiobiology, Mount Vernon Hospital, Northwood, Middlesex.

LABORATORY TECHNICIAN (with experience of food and toxicological analysis) IN THE DEPARTMENT OF VETERINARY HYGIENE AND PREVENTIVE MEDICINE, University of Edinburgh—The Secretary, The University, Old College, South Bridge, Edinburgh.

LECTURER (with a degree in biochemistry and/or chemistry, including organic chemistry taken to an advanced stage, and preferably with experience in the analysis of foods, including dairy products) IN AGRICULTURAL BIOCHEMISTRY, at Massey Agricultural College (University of New Zealand), Palmerston North—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

LIVESTOCK OFFICER (with a university degree either in dairy husbandry or in agriculture with specialization in animal husbandry, and some experience in stock management) IN THE VETERINARY DEPARTMENT, Nyassaland, for duties connected with the development of the local animal industry, mainly in African areas—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD 67/4/08.

SCIENTIFIC OFFICER (with at least a first- or second-class honours degree in mathematics or physics and a thorough practical and theoretical knowledge of geometrical optics) to carry out research in instrument requirement assessment and also to apply this research to the design of a wide variety of optical instruments including photographic lenses.—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 555/WGE/2

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (honours graduate with research ability, and preferably with experience of small-scale metal fabrication), at the Atomic Energy Research Establishment, Harwell, to work on the application of novel and unconventional techniques to fundamental research on the fabrication of an unusual metal.—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/259.

* TRAINED TECHNICIAN IN THE BOTANY DEPARTMENT.—The Registrar, University College of Wales, Aberystwyth.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

"The Earth is the Lord's." By the Rev. C. E. Raven. (An address to the 1954 Conference of the Institute of Rural Life at Home and Overseas.) Pp. 12. (London: Institute of Rural Life at Home and Overseas, 1954.) 6d.

British Hat and Allied Feltmakers Research Association. Seventh Annual Report of the Director of Research for the year ending August 1954. Pp. 19 (2 plates). (Manchester: British Hat and Allied Feltmakers Research Association, 1954.)

Department of Scientific and Industrial Research. Forest Products Research. Bulletin No. 33: The Strength Properties of Plywood. Part 2: Effect of the Geometry of Construction. By W. T. Curry. Pp. iv+28+4 plates. (London: H.M. Stationery Office, 1954.) 2s. net.

Bulletin of the British Museum (Natural History). Zoology. Vol. 2, No. 9: A Collection of Mesostigmatid Mites from Alaska. By G. Owen Evans. Pp. 285-307. 7s. Entomology. Vol. 3, No. 13: Revisional Notes on the Genus *Epilota* Westwood (Lepidoptera: Lyncenidae). By Patrick Roche. Pp. 489-502+plates 19-22. 8s. Vol. 3, No. 14: African Species of the Genus *Paradomina* Warren (Lepidoptera: Pyralidae: Pyraustinae). By Edward L. Martin. Pp. 503-521+plate 25. 7s. (London: British Museum (Natural History), 1954 and 1955.)

British Museum (Natural History). British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report. Geology. Vol. 2, No. 1. The Volcanic Rocks of the Ross Archipelago. By W. Campbell Smith. Pp. 107+6 plates and 2 maps. (London: British Museum (Natural History), 1954.) 60s.

National Parks and Access to the Countryside Act, 1949. Fifth Report of the National Parks Commission for the year ending 30th September 1954. Pp. iv+56+8 plates. (London: H.M. Stationery Office, 1954.) 3s. 6d. net.

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. North Western Division. By G. Hoyle. Pp. ii+26+5 plates. 2s. net. East Midland Division. By W. B. Brown. Pp. ii+20. 1s. net. (London: H.M. Stationery Office, 1954.)

Ministry of Education. Early Leaving: a Report of the Central Advisory Council for Education (England). Pp. vii+99. (London: H.M. Stationery Office, 1954.) 3s. 6d. net.

Science and Religion: a Changing Relationship. By Prof. C. A. Coulson. (Rede Lecture for 1954.) Pp. 36. (Cambridge: At the University Press, 1955.) 2s. 6d. net.

British Social Biology Council. Alpha and Omega: a Study of some Religious and Biological Teaching in Schools on the Origin of Life and of Man. By Dr. L. M. J. Kramer. (Educational Paper No. 7.) Pp. 22. (London: British Social Biology Council.) 1s. 9d.

Privy Council. Medical Research Council Memorandum No. 20: Indices of Heat Stress—a Statistical Comparison of Effective Temperature and an Index based on Sweat Loss. By F. E. Smith. (A Report based on experiments carried out at the National Hospital for Nervous Diseases, Queen Square, London, by B. McArdle, W. Dunham, H. E. Holling, W. S. S. Ladell, J. W. Scott, M. L. Thomson and J. S. Weiner.) Pp. 52. (London: H.M. Stationery Office, 1955.) 2s. net.

Other Countries

Imperial College of Tropical Agriculture. A Report on Cacao Research, 1953. Pp. 87 (11 plates). (St. Augustine, Trinidad and London: Imperial College of Tropical Agriculture, 1954.)

United States Naval Observatory. Circular No. 53. Annular Eclipses 1958, 1959. By Simone Daro Gossner. Pp. 4. Circular No. 54: Positions, Areas, and Counts of Sunspots, July-August, 1954. By Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: U.S. Naval Observatory, 1954.)

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 119, No. 3: Status of Invertebrate Paleontology, 1953. Edited by Bernhard Kummel. Pp. 91-313. Vol. 112, No. 4: Revision of the Chrysomelid Subfamily Aulacocelinae. By F. Monrós. Pp. 819-860. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.)

Institut pour la Recherche Scientifique en Afrique Centrale. Pp. 14+13 plates. (Bruxelles: L'Institut pour la Recherche Scientifique en Afrique Centrale, 1954.)

Colony of Mauritius. Annual Report of the Observatory Department for the year 1953. Pp. i+16. (Port Louis: Government Printer, 1954.)

Royal Alfred Observatory, Mauritius. Results of Magnetical and Meteorological Observations. July, 1950. Pp. 14. August, 1950. Pp. 14. September, 1950. Pp. 14. October, 1950. Pp. 14. November, 1950. Pp. 14. December, 1950. Pp. 18. (Port Louis: Government Printer, 1954.)

Carnegie Institution of Washington. Report of the President for the year ending June 30, 1954. Pp. 15. (Washington) D.C.: Carnegie Institution of Washington, 1954.)

Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1953. Pp. x+64. (Hyderabad: Deccan: Central Laboratories for Scientific and Industrial Research, 1954.)

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 35, No. 11: Improved Outlook for Surgical Patients. Pp. 12. (New York: Metropolitan Life Insurance Company, 1954.)

The Geophysical Observatory: a Study in Technical Assistance. Pp. 35+4 plates. (Karachi: Ministry of Education, 1954.)

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon). No. 10: July-December, 1953. Pp. iii+358. (New Delhi: Unesco, South Asia Science Co-operation Office, 1954.)

Research Bulletin of the Panjab University. Nos. 49-50 (Zoology): On Three New Species of the Genus *Cephalogonimus* Poirier, 1886, from the Intestine of *Lissemys punctata* Punctata. On Five New Trematodes of the Genus *Astiotrema* Looss, 1900, from the Intestine of *Lissemys punctata* Punctata, and discussion on the Synonymy of Two Already Known Forms. By Dr. N. K. Gupta. Pp. 71-100. 3 rupees.

No. 51 (Zoology): Taxonomic Values of Chromosomes and Cytoplasmic Inclusions in a Digenetic Trematode—*Phyllodistomum spatula*. By Om Parkash Dhingra. Pp. 101-109. 1 rupee, 7 annas.

No. 52 (Chemistry): The Phenomenon of Continuous Freezing of Capillary-held Water at Decreasing Temperatures. By Balwant Rai Puri, Lakh Raj Sharma and M. L. Lakhnani. Pp. 111-116. 15 annas.

No. 53 (Zoology): On *Mehraorchis tigrina*, a New Species from the Stomach of *Rana tigrina*. By Dr. N. K. Gupta. Pp. 117-120. 12 annas.

No. 54 (Zoology): On a New Species of the Genus *Ommatobrepus* Nicoll, 1914, from the Intestine of *Natrix piscator* in Ludhiana. By Dr. N. K. Gupta. Pp. 121-123. 10 annas.

No. 55 (Zoology): On a New Species of the Genus *Ganeo* Klein, 1905, from the Intestine of *Rana cyanophyllus*. By Dr. N. K. Gupta. Pp. 125-129. 12 annas.

No. 56 (Zoology): On Two New Species of Trematode Parasites from Birds in Hoshiarpur. By Dr. N. K. Gupta and B. K. Dhillon. Pp. 131-137. 1 rupee.

No. 57 (Zoology): On *Encyclometra vitellata*, a New Species from Water-Snail, *Natrix piscator*. By Dr. N. K. Gupta. Pp. 139-141. 10 annas.

No. 58 (Zoology): On *Pleurogenes (Telogonella) saunensis*, N. S.P., Parasitic in the Intestine of *Rana cyanophyllus*, with a discussion on the Systematic Position of the Genus *Pleurogenes* Looss, 1896. By Dr. N. K. Gupta. Pp. 143-148. 14 annas.

No. 59-60 (Zoology): Microphotographs Demonstrating the Vacuole, Golgi Bodies, Mitochondria and Nuclear Extrusions in the Fresh Eggs of Frog as studied under the Phase Contrast Microscope. By Vishwa Nath and Kumar Malhotra. An Examination of the Yolk-Nucleus of the Spider *Pleuropus paykulli* under the Phase Contrast Microscope. By Vishwa Nath and Rajmud M. Dhawan. Pp. 149-157. 1 rupee, 7 annas.

No. 61 (Zoology): Spermatogenesis of a Digenetic Trematode *Cyclocoelum bivesiculatum*. By Om Parkash Dhingra. Pp. 159-168. 1 rupee, 12 annas.

No. 62 (Zoology): Fish Spermatogenesis with particular reference to the fate of the Cytoplasmic Inclusions. 3. Spermatogenesis of Actinopterygii (Cyprinodontidae). By Hem Sagar Vasisht. Pp. 169-175. 1 rupee, 2 annas. (Hoshiarpur: Panjab University, 1954.)

Annual Report of the Kodakkanal Observatory for the year 1953. Pp. 10. (Delhi: Manager of Publications, 1954.) 9 annas; 10d.

Faculty of Science. Osaka University. Annual Report of Scientific Works. Vol. 2. Pp. 125 (2 plates). (Osaka: Faculty of Science, Osaka University, 1954.)

National Institute of Genetics (Japan). Annual Report—No. 4 (1953). Pp. ii+69. (Mitsima, Sizuoka-Ken: National Institute of Genetics, 1954.)

Institut Royal Météorologique de Belgique. Publications Série B, No. 12: Ensoleillement et Orientation en Belgique—V. Étude de l'éclairement lumineux naturel. Par R. Dogniaux. Pp. 76. Contributions. No. 14: Prévisions numériques en météorologie. Par P. Defrise. Pp. 15. No. 15: L'aérodologie des nauges à développement vertical. Par Dr. A. Descamps. Pp. 16. (Eccle-Bruxelles: Institut Royal Météorologique Belgique, 1954.)

World Health Organization. Technical Report Series. No. 90: Bilharzia Snail Vector Identification and Classification (Equatorial and South African). Report of a Study Group. Pp. 22. 1 Swiss franc; 1s. 9d. net; 0.25 dollars.

No. 91: Expert Committee on Nursing. Third Report. Pp. 28. 1 Swiss franc; 1s. 9d. net; 0.25 dollars. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.)

Journal of the Japanese Obstetrical and Gynecological Society. English edition. Vol. 1, No. 1 (January 1954). Pp. 34. (Tokyo: Japanese Obstetrical and Gynecological Society, 1954.)

Federation of Malaya. Annual Report of the Institute for Medical Research for 1953. Pp. v+104. (Kuala Lumpur: Government Printer, 1954.) 2 50 Malayan dollars; 5s. 10d.

Editorial and Publishing Offices of "NATURE"

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831. Telegrams: Phisus Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

NATURE

No. 4458

SATURDAY, APRIL 9, 1955

Vol. 175

CONTENTS

	Page
Development of Nuclear Power in Britain	609
Science in Early China. By Prof. E. D. Edwards	612
Text-books of Geology	613
Bile Pigments. By Prof. C. H. Gray	613
Ecology of Freshwater Molluscs. By Dr. N. B. Eales	614
International Conference on the Peaceful Uses of Atomic Energy	615
Emil Behring and Paul Ehrlich: Their Contributions to Science. By Prof. C. H. Browning, F.R.S.	616
The Indian Agricultural Research Institute. By Sir John Russell, O.B.E., F.R.S.	619
Obituaries:	
Sir Godfrey Thomson. By Prof. A. C. Aitken, F.R.S.	620
Prof. C. O. Bannister. By Dr. S. W. Smith, C.B.E.	621
News and Views	622
The Earth's Magnetic Field and Numerical Weather Forecasting. By Dr. E. T. Eady.	626
Buffalo Hunting in Arnhem Land	627
Microwave Amplification by Stimulated Emission of Radiation	628
Myxomatosis of Rabbits. By Dr. G. Lapage	628
Chemical Synthesis of Porphobilinogen. By K. S. N. Prasad and Dr. R. Raper; Prof. C. Rimington, F.R.S., and S. Krol	629
Conditions of Explosion of Azides. By Dr. F. P. Bowden, F.R.S., and A. C. McLaren; Dr. J. S. Courtney-Pratt and G. T. Rogers	631
Letters to the Editors:	
Anthocyanins of the Leaf of the Copper Beech (<i>Fagus sylvatica</i>) and the Fruit of the Cultivated Strawberry (<i>Fragaria virginiana</i>).—Sir Robert Robinson, O.M., F.R.S., and Dr. Herchel Smith	634
Release of Aromatic Compounds from Birch and Spruce Sawdusts during Decomposition by White-rot Fungi.—M. E. K. Henderson.	634
Synthesis of Oligosaccharides by Growing Cultures of <i>Betacoccus arabinosaceus</i> .—R. W. Bailey, Dr. S. A. Barker, Dr. E. J. Bourne and Prof. M. Stacey, F.R.S.	635
Utilization of Metaphosphate for Phosphorylation by Cell-free Extracts of <i>Mycobacterium smegmatis</i> .—Frank Winder and Joan M. Denny.	636
Tumour-initiating Action of Urethane and its Inhibition by Purine Precursors.—F. J. C. Roe	636
Histochemical Control in Biochemical Estimation of Prostatic Phosphatase Activity.—D. Brandes and Dr. G. H. Bourne	637
Recovery of the Complementary Products of Mitotic Crossing-over.—J. A. Roper and R. H. Pritchard	639
Vibrations of the Substrate and Stridulation in a Grasshopper.—P. T. Haskell	639
Plant Mitochondria and Salt Accumulation.—R. N. Robertson, Marjorie J. Wilkins and A. B. Hope	640
Occurrence of the Black Rat in Sewers in Britain.—R. A. Davis	641
The Rostrum of <i>Centrocnemis</i> Signoret 1852.—N. C. E. Miller	641
Light Sensitivity of the Aquatic Flatworm <i>Dendrocoelum lacteum</i> .—Dr. M. H. Pi-enne and Dr. F. H. C. Marriott	642
An Asymmetrical Response of Teleost Melanophores.—E. G. Gray	642
Influence of Dietary Antibiotic Supplements on the Visceral Weights of Pigs.—H. Taylor and G. Harrington	643
Ionization in Fatty Acid Mono-layers on Pure Water.—J. V. Sanders and J. A. Spink	644
Proton Magnetic Resonance Spectra of Coals.—P. C. Newman, L. Pratt and Dr. R. E. Richards	645
Excitation Processes and the Theory of the Arc Discharge.—A. E. Robson and Dr. A. von Engel	646
Optical Aspherizing by Vacuum Evaporation.—J. A. Dobrowolski and Dr. W. Weinstein	646
The Yellow Emission Line of the Solar Corona.—David Layzer	647
Conductivity induced in Mica by X-Rays.—J. F. Fowler and Dr. F. T. Farmer	648

Editorial and Publishing Offices of Nature*

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1

Telephone Numbers: Regent 3801

All rights reserved. Registered as a newspaper at the General Post Office

Just out

PROGRESS IN *Low Temperature*

E D I T O R *Physics*
C. J. GORTER

CONTRIBUTORS:

J. J. M. Beenakker, J. de Boer, A. H. Cooke, J. G. Daunt, T. E. Faber, R. P. Feynman, C. J. Gorter, E. F. Hammel, A. C. Hollis Hallett, A. van Itterbeek, D. de Klerk, K. Mendelssohn, L. Néel, J. R. Pellam, A. B. Pippard, N. J. Poulis, B. Serin, C. F. Squire, M. J. Steenland, K. W. Taconis, L. Weil.

In the present volume recent research and the present status of knowledge in several fields of low temperature physics are reviewed.

The three main fields—magnetism, liquid helium and superconductivity—receive ample attention, and a choice of the most promising of other subjects is given.

1955 420 pp. 100 fig. 61 sh. (\$ 8.00)

Sole agency for U.S.A.:
Interscience Publishers, Inc., New York



NORTH-HOLLAND PUBLISHING COMPANY
NIEUWE ZUIDS-VOORBURGH 4-10 AMSTERDAM-C. HOLLAND

COMING SOON!

THE HISTORY OF THE TELESCOPE

By H. C. King, Ph.D., M.Sc.

Fellow of the Royal Astronomical Society,
Fellow of the British Optical Association,
Senior Lecturer in Ophthalmic Optics,
Northampton Polytechnic

THE Astronomer Royal, Sir Harold Spencer Jones, remarks in his Foreword that this book fills a notable gap in astronomical literature. It is indeed curious that, although many histories of astronomy have been written, none has devoted more than a chapter or two to the development of the principal instrument of the science. Dr King's great new work has over 450 Crown Quarto pages. It is profusely illustrated and thoroughly documented. Approx. 50s.

CHARLES GRIFFIN & CO. LTD
42 DRURY LANE, LONDON, W.C.2

U.S.A. rights held by
Sky Publishing Corp.,
Harvard Observatory,
Cambridge 38, Mass.

PRECISION



INSTRUMENTS

Spectrograph with quartz optical system

Critical definition is obtained over the entire range of the spectrum. Size of photographic plate 12 in. x 3 in.



A larger instrument can now be supplied giving a 12 in. length of spectrum between 8000A and 2100A.

Full particulars from the Manufacturers:

Bollingham & Stanley Ltd. DEPT. N, 71 HORNSEY RISE, LONDON, N.19

We Export for Dollars

WM. DAWSON & SONS, LTD.

World's Largest Stockists of Scientific Periodicals

Complete Libraries Purchased

BUYING?

SELLING?

Suppliers to All Leading Universities, Public Libraries and Institutions of the World. Cats. issued

Specialists in Scientific, Technical Books and Publications of all Learned Societies

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1 Telephones: Wel. 7948; Amb. 5991

DEVELOPMENT OF NUCLEAR POWER IN BRITAIN

IT was appropriate that the White Paper outlining the Government's programme in connexion with nuclear power* should be published in the same week as the Statement on Defence† which announced the Government's intention to undertake the development and production of thermonuclear weapons. Whether we are concerned with the military programme, or with the production and use of radio-isotopes and other peaceful applications of nuclear energy, progress is ultimately determined by the magnitude of our scientific and technical resources, the ability of our scientists to discover the secrets of Nature and on our speed in applying the new techniques that science has taught us. These indeed, as the White Paper reminds us, are the factors which likewise determine the future of Britain as an industrial country. The Defence debate in the House of Commons showed little awareness of the limitations which might be imposed by shortage of scientific man-power, but that could not be said of the earlier debate on February 25 on a motion of Mr. Ronald Bell's welcoming the Government's programme for the development of nuclear power.

Congratulating the Government on the courage and imagination shown in putting forward this programme, and also paying tribute to the work of the Atomic Energy Authority, Mr. Bell referred to the possibility that the programme could absorb the whole output of physics graduates from British universities for several years to come. That clearly could not be allowed to happen; but, as Mr. Bell rightly said, the programme may well intensify the shortage of scientists and it gives yet greater urgency to the problem of science teachers. The recommendations of the Burnham Committee for special allowances for teachers of advanced work which the Government has accepted should have some effect; but the action which Sir David Eccles said as recently as March 3 that he was still considering in regard to the shortage of science teachers now assumes importance in respect both of defence policy and the development of nuclear power.

That could also be said of the expansion of technological education to which also Mr. Bell referred, as did even more emphatically Mr. Bernard Braine, Mr. F. Willey, Mr. George Chetwynd and Mr. M. Follick. Mr. Braine put the question in a somewhat wider context in referring to our relative expenditure on fundamental research and on applied research and the dissemination of information. Quoting the Government provision for research in the current year as £20·7 million, apart from that proportion of the recurrent grants to the universities spent on research, he urged a closer scrutiny of fundamental research and greater readiness to discontinue fruitless lines and so avoid waste of effort, and also that more Government resources should be expended on applied

research. While Britain's expenditure on defence research has not been disclosed, the total expenditure of the United States last year on all kinds of research, including defence, was estimated at £750 million. In particular, he suggested that more assistance might be given to medical research in such matters as radiation sickness.

In replying for the Government in the debate, the Minister of Works, Mr. Nigel Birch, admitted that a main factor in the speed with which the programme is developed will be our ability to train the men we need, and he recognized that the universities and industry as well as the Atomic Energy Authority will play a part. Mr. Birch mentioned particularly the efforts being made at Queen Mary College, London, and at the Universities of Birmingham and Manchester. A six weeks full-time postgraduate course on nuclear engineering (the use of the term 'engineering' is noteworthy) at Manchester is specially designed for industrialists, and the Government hopes that in time all universities will give basic courses in nuclear and reactor physics. As regards the training courses at Harwell, the object is to build up teams from the British Electricity Authority and teams including consulting engineers, heavy electrical engineers and other engineering firms which would be competent to execute the plans outlined in the White Paper.

Mr. Birch referred also to some of the more imaginative uses which are being made of radioactive isotopes, and said that the Atomic Energy Authority is always willing to help with any problem which the use of isotopes or nuclear technology promises to solve. Frequent reference was made in the debate to the question of safety. The statement in the White Paper that it is impossible for an 'atomic explosion' to occur in a power reactor was emphasized, and in support of the assertion that if nuclear power facilities are properly designed any accidents that occur will be no more dangerous than accidents in many other industries, Mr. Birch could point to the exceptionally good record of safety of the Authority. The main hazards in a nuclear power station are caused by the concentration of highly radioactive materials; but these are known dangers, and in guarding against them by precautions in the design of the reactor itself and, if necessary, enclosing part or all of it in a gas-tight container we are, as Mr. Birch reminded the House, not starting from scratch.

The debate appeared to be of some value in dispelling misgivings on the grounds of safety, and also in regard to the disposal of atomic waste. This is not a major problem and is primarily one for the chemical processing plants, which will be few in number, and not for the power stations. As the White Paper indicates, the volume of waste will be small, and, apart from the efforts being made to determine the most economical methods of storage or disposal, much of the output should be absorbed by the valuable uses already discovered; any material discharged will be tested to ensure that it is of extremely low

* A Programme of Nuclear Power. Pp. ii+22. (Cmd. 9389.) (London: H.M. Stationery Office, 1955.) 9d. net.

† Statement on Defence, 1955. Pp. 30. (Cmd. 9391.) (London: H.M. Stationery Office, 1955.) 1s. net.

radioactivity, so that it will be harmless and comparable in effect to the natural background radioactivity always present. Mr. Birch gave a forthright assurance on this point; but there is clearly room for publicity to dispel the unreasonable fears which have already been encountered, for example, in the Forest of Dean.

While the debate may assist in this respect, its chief interest lies in the evidence it affords of the support from all parties for the Government's programme, the extent to which the implications of that programme are understood in Parliament and the well-deserved tributes paid to British science and technology in this field. It is clear, for example, that the Government intends to make it possible for British industry to acquire the experience necessary for the full exploitation of nuclear power by providing opportunity for first-hand experience with the problems of the design and building of nuclear plant. The use of nuclear fission as a source of heat to drive electric generating plant on a commercial scale appears practicable, moreover, when the great and growing demand for energy, and especially for electric power, places an increasing strain on the supplies of coal in Britain and makes the search for supplementary sources of energy a matter of urgency. Accordingly, as Mr. Geoffrey Lloyd, Minister of Fuel and Power, indicated in his statement on February 15, this programme is of crucial importance to the national economy and has an essential place in the Government's fuel policy. The provisional programme would provide 1,500–2,000 megawatts of nuclear power by 1965 and between 10,000 and 15,000 megawatts by 1975, and by levelling off the coal required by power stations in the region of 60–70 million tons a year would help to meet the difficulties in finding manpower for the mines and producing sufficient coal at reasonable cost for other users of solid fuel.

The decision to proceed with this provisional nuclear power programme does not depend on precise comparisons of cost; but it is estimated that with the two types of reactor to be brought into use on a commercial scale during the next ten years—the gas-cooled graphite-moderated 'thermal' reactor now being constructed at Calder Hall, using natural uranium or slightly 'enriched' uranium as fuel, and a liquid-cooled 'thermal' reactor which could use the plutonium produced in the earlier reactors in conjunction with natural uranium—the cost of electricity, taking a reasonable value for the plutonium, would be about 0.6d. a unit. If reactors of the fast breeder type, now being built at Dounreay, which should be producing electricity in 1957, are eventually used, the net cost of fuel would be greatly reduced; but the provisional programme does not contemplate using such reactors, since the necessary data and experience will not be available in time.

These estimates assume that all the plutonium is used for civil purposes, and the programme is based essentially on the assumption that the development of nuclear power has reached a stage when it is vital for us to apply it commercially with all speed if we are to keep our place as a leading industrial nation and reap the benefits nuclear power offers. It should

be remembered, moreover, that in these comparative estimates of cost, no allowance is made for the rise in the price of solid fuel that would accompany the failure of supplies to keep pace with demand or for the effect of such failure on the national economy. These considerations alone would justify the effort which the provisional programme demands; and criticism of the programme in the House of Commons centred rather on the rate of progress than on the magnitude of programme. While the Government considers that enough uranium will be available for this programme over the next ten years, the programme as outlined represents the most that can reasonably be expected in the light of existing knowledge. If no unexpected difficulties or shortages of man-power or materials are encountered, progress may well be more rapid than is forecast; equally it could be slower.

The nuclear power stations will be built in the normal way by private industry for the electricity authorities, which will own and operate them. The Atomic Energy Authority will be responsible for giving technical advice on the nuclear plant; but British industry and consulting engineers have a major task in training staff, in creating the necessary organization and in designing the stations. Although this work has already begun, it will not be practicable to start building any commercial stations before 1957, when construction of two gas-cooled graphite-moderated stations (each with two reactors) will be started. These stations should come into operation during 1960–61.

Meanwhile, in 1958–59 construction of two further stations, similar in type, but with improved performance, particularly in heat rating, is planned, followed by four more in 1960 and a further four in 1961–62. These might come into operation in 1963–64 and the last four might be of the liquid-cooled type, which should then have been developed sufficiently to be economically satisfactory. Thus, if all goes well, by the end of ten years Britain should have twelve large nuclear power stations saving coal to the extent of five to six million tons a year and providing 1,500–2,000 megawatts, the latter figure being approximately equal to the new generating capacity which Britain is expected to be needing each year by the end of ten years. By 1964, the early reactors should be supplying several hundred kilograms of plutonium a year. This would be available for enriching the fuel charges in later reactors, which in turn would produce plutonium more rapidly, thus making it available for a rapidly expanding programme of reactors requiring enriched fuel in the late 1960's.

The capital expenditure involved by this programme is considerable. For the first two stations it is put between £30 million and £35 million. The next two stations, with a much higher output, will probably cost slightly more, and the last eight stations a total of about £125 million. With a further £40 million for the initial charges of uranium, including fabrication, new ancillary plant costing £30 million over the decade and concurrent capital expenditure on prototype development of £30–40

million, the cost of the ten-year programme is likely to exceed £300 million, since the rate of expenditure on commercial applications of nuclear power is likely to rise steadily during the period, and expenditure on stations which will not be completed until after 1965 does not appear in the present programme.

While this investment is not wholly an additional demand on the economy, it is obviously of a magnitude which will put a considerable strain on the capital resources of Britain, as well as on the supplies of material and man-power. The Government professes to be satisfied that the country can afford the proposed rate of investment, and the demands which the programme makes upon materials and on scientific and technical man-power; though it appears to regard the latter as the limiting factor for the present. The White Paper points out that in the absence of nuclear power, the electricity authorities would be required to invest some £1,200 million over this decade in new coal- or oil-fired generating capacity. Moreover, from about 1965, it may be economically desirable to build nuclear power stations instead of coal-fired stations, even without taking account of any long-term difficulties in the supply of coal. By 1965 the new nuclear power stations should be meeting a quarter of the total requirement of new generating capacity.

Any attempt to forecast developments after 1965 is clearly premature. Too much depends on the speed of technical development and the success of the early stations as well as on the speed with which the necessary techniques are mastered by industry as a whole. The supply of nuclear fuel may also be a limiting factor, though it is suggested that uranium is more plentiful than was once thought and that greater economy in its use may offset some of the demand, as well as developments in the use of thorium as substitute. Even so, the White Paper forecasts the possibility of nuclear power stations meeting the total requirements of new generating capacity in Britain by the early 1970's, and by 1975 producing electricity at a rate equivalent to a saving of 40 million tons of coal a year.

Before considering the scientific implications of the programme more particularly, two further points made in the White Paper should be noted. It is emphasized that the Government intends to play a full part in the international scientific conference on the peaceful uses of nuclear energy to be held in August, and that it is anxious to promote international co-operation in this field. So far as resources permit, it proposes to provide further facilities for physicists and engineers from other countries to attend the Reactor and Isotope Schools at Harwell, and to help other countries to build experimental and developmental reactors. It would seem to be sounder policy to concentrate the resources of Britain upon providing training facilities rather than to supply from among our own limited numbers of physicists and engineers the experts which other countries will require to build their nuclear energy plants.

The White Paper also refers to the possibility of building up a valuable export trade. This has already

been achieved in radioactive isotopes. The experience gained by British industry in designing and building nuclear power stations during the next ten years should lay the foundations for a rapid expansion both at home and overseas. At present, nuclear power generation is still in the development phase. If, however, this pioneering programme is carried out with imagination and energy as well as with sound technical judgment, the construction and operation of such stations will become standard engineering practice and we shall then be in a position to fulfil our traditional rôle as an exporter of skill, to the benefit both of ourselves and the rest of the world.

It will be noted that the Atomic Energy Authority, while giving as much assistance and advice to industry as possible, will remain primarily a research and development organization, and will continue to design, build and operate pioneering types of power reactor. The Authority will also be responsible for buying uranium, fabricating the fuel elements, processing the used fuel and extracting the plutonium from it. Nevertheless, it is broadly true that the programme as outlined is a tribute to the achievements of British nuclear scientists and technologists, and simultaneously a challenge to British industry to turn these achievements swiftly to account.

The soundness of the economic assumptions in this provisional programme need not be discussed here. What is important is that the implications for science and technology should be clearly understood. In the first place, there is a continuing need for research, notably in problems of constructional materials and heat transfer, as well as in nuclear physics. Chemists and chemical engineers as well as physicists and mechanical and electrical engineers will be required for research as well as for constructional purposes. We are given no hint as to the extent of that demand or of the possible effect on the universities of a response to the appeal to provide courses in nuclear and reactor physics. In at least certain categories the shortage of scientific and technical man-power is likely to become even more acute.

Something more will obviously be required than the circular which the Federation of British Industries has now sent to its members, or the new allowances for teachers of advanced work recommended by the Burnham Committee, if the shortage of science teachers is not to curtail very seriously during the next decade the supply of physicists and other scientists needed for the programme. The programme itself could perhaps be used for demonstrating to parents, schoolmasters and pupils the opportunities and the national importance of a scientific and an industrial career. But it is equally important that some further attention should be given to the distribution and balance of our existing scientific and technical man-power.

What the programme demands above all is a conspectus of the scientific and technical man-power of Britain, a survey which the Government has hitherto refused to face. A programme of nuclear power cannot wisely be considered or pursued in isolation. Regard must be had to the demands of many other

vital sectors of the economy—to the impending programmes of road construction, of re-equipping the railways, of handling air pollution and fuel policy, as well as scientific and industrial research by government agencies, the national corporations and private industry, and also Colonial development and welfare programmes and technical assistance schemes overseas. The effect upon research and upon teaching at the universities must also be considered, and our policy of technical and technological education as well as of university education may equally require adjustment.

There is required, in fact, what may be described loosely as a national policy for science and technology. It is equally forced upon us by the demands of defence on science and technology, and neither the Advisory Council on Scientific Policy nor the Defence Research Policy Committee is by itself adequate. The major responsibility lies on the Lord President of the Council, who has still an inadequate staff, and who is without a spokesman in the House of Commons. The Parliamentary and Scientific Committee could render no greater service at this juncture than to press upon the Government the need for establishing adequate means for reviewing at a high level the implications of all the conflicting demands which such programmes place upon our scientific and technical resources; unless this is done, it is difficult to see how to avoid creating bottlenecks or distorting the balance of that effort in ways detrimental to the national welfare. Moreover, such representations would come the better from an all-party body, for the avoidance of waste and inefficiency depends increasingly on the extent to which our scientific and technical effort is applied continuously in the chosen directions and is not disturbed or deflected by party political considerations in matters where scientific and technical factors should be the first determinants. Nor should such an approach fail to promote the climate in which creative scientific and technological work and initiative best flourish, by stimulating the freer exchange of knowledge and ideas and the removal of secrecy measures which endanger rather than promote national security. It should also stimulate the imaginative consideration of the social and industrial consequences of the wider use of electric power and of the methods of automatic control which nuclear power promises to place within our reach.

SCIENCE IN EARLY CHINA

Science and Civilization in China

By Dr. Joseph Needham. With the research assistance of Wang Ling. Vol. 1: Introductory Orientations. Pp. xxxviii+318+13 plates. (Cambridge: At the University Press, 1954.) 52s. 6d. net.

IN this volume we have the beginnings of one of the most interesting books on China that has appeared for a long time. In later volumes (some of which are finished or even in the press), Dr. Joseph Needham will deal with astronomy and geography (Vol. 3), textile technology (Vol. 4), alchemy and chemistry

(Vol. 5), and biology, agriculture and medicine (Vol. 6). There is, therefore, much to wait for. Dr. Needham is well equipped for the task he has set himself. Not only is he an eminent scientist, but also he is a scholar well fitted with the tools of sinology.

In the first volume of the series he discusses such matters as a geographical and historical introduction, and conditions of progress of scientific ideas and techniques between China and Europe, so that by reading the present volume we may be well prepared for the six volumes that are yet to come.

No book has appeared which attempted to bring into line such things as an account of the travels of the Emperor Mu, the influence of Chinese mathematics on Hindu mathematics, or the "Pên Tshao" series of works (herbals to be used in pharmacy or for the prevention of famine). The question of the westward flow of techniques is also dealt with—the rotary fan and the winnowing machine. The two efficient harnesses for draft animals, canal lock gates, printing and porcelain, and many other subjects are discussed and will be treated in greater detail in later volumes.

Of the introduction of natural products into China, Dr. Needham speaks of the grape-vine and alfalfa, which are clearly attributed to Chang Ch'ien (140 B.C.) in the "Shih Chi", as well as the chive, coriander, cucumber, fig, pomegranate and walnut introduced at various times between the third and seventh century A.D. Of these, no fewer than five have names which include the word *Hu*, meaning Central Asia or Persia.

One of the interesting things of which Dr. Needham writes is the striking water-clock; but there is one T'ang reference which he does not quote. In the "Ch'ao yeh Ch'ien tsai" (par. 25 B), by Chang Tsu, who was born in A.D. 660, is a description of a clock the English translation of which reads: "In A.D. 692, during the reign of the Emperor Wu, craftsmen from Hai-Chou made a revolving time piece. When it turned due south, it was midday, and a door opened and horse-headed men appeared. It revolved without the slightest inaccuracy" (E. D. Edwards, "Chinese Prose Literature of the T'ang Period", Vol. 1, p. 77). However, perhaps this will be referred to in a later volume.

On "What not to forget to take with you on a Journey" ("Wang Huai Lu"), Dr. Needham mentions a raincoat, a medicine chest, spare clothes, a bag of preserved goods and tea, another containing paper, ink, scissors, a rhyming dictionary and a lute. Candles, knives, chessmen and a folding chess-board must also not be forgotten. As this was written in the Sung Dynasty, about A.D. 1070, it may be seen that the Chinese did not travel too lightly. The list might be suitable if one were travelling in China now.

One of the most important of Dr. Needham's statements is the following: "Whenever one follows up any piece of scientific or zoological history in Chinese Literature, it is always at the Sung Dynasty that one finds its major focal point. This is true for applied as for the pure sciences". If one looks at chemistry or medicine, one finds that this is so, and as is well known, the use of explosives was discovered and they were utilized in the Chin-Sung wars. In the Sung period, books on pharmaceutical botany "reached an unprecedentedly high standard and several recensions of the *Pên Tshao* or Codex were produced". There were also monographs on bamboos, aromatic plants and flowering trees as well as Crustacea, birds and fishes. About A.D. 1111 an

Imperial Medical Encyclopædia, the "Shêng chi tsung lu", was compiled by twelve of the most eminent medical men of the time.

Dr. Needham has included bibliographies of Chinese books before A.D. 1800, Chinese and a few Japanese books and general articles since A.D. 1800, and books and general articles in Western languages. Apart from the paucity of Japanese books, the bibliographies are excellent. The work is beautifully produced by the Cambridge University Press, and we eagerly and impatiently await the later volumes.

E. D. EDWARDS

TEXT-BOOKS OF GEOLOGY

Petrography

An Introduction to the Study of Rocks in Thin Sections. By Howel Williams, Francis J. Turner and Charles M. Gilbert. (A Series of Geology Texts.) Pp. x+406. (San Francisco: W. H. Freeman and Company; London: Bailey Bros. and Swinfen, Ltd., 1954.) 6.50 dollars; 56s.

Rocks and Mineral Deposits

By Prof. Paul Niggli. English translation by Prof. Robert L. Parker. (A Series of Geology Texts.) Pp. xiii+560. (San Francisco: W. H. Freeman and Co.; London: Bailey Bros. and Swinfen, Ltd., 1954.) 12 dollars; 102s.

ALTHOUGH, within the confines of the British Isles, there occurs an immense variety of rocks, igneous, sedimentary and metamorphic, as well as many deposits of economic minerals of a diverse character, the number of British text-books of university standard describing these rocks and their origins is quite small. Text-books by authors who have studied rocks in other countries, and whose attitude to the problems involved may differ from that of British authors, should, therefore, have a definite value for British students, as a means of broadening their outlook. Both the works noticed here form useful additions to the range available.

Messrs. Williams, Turner and Gilbert's "Petrography" forms an excellent introduction to the subject for first- and second-year students, more especially because it deals with the three main rock groups—igneous, sedimentary and metamorphic—within the limits of a text-book of average size. The work is fully illustrated with a large number of figures carefully drawn from selected thin sections of typical rocks, half of which have been chosen from sources outside the United States. As the authors state, previous text-books of this standard have devoted too little attention to sedimentary rocks; but it surely ought not to be necessary to advance as justification for the inclusion of an adequate description of the rocks of this class the fact that in the United States most graduates in geology now enter the petroleum industry.

The second book noticed here is essentially a translation of the first volume of the late Prof. P. Niggli's "Gesteine und Minerallagerstätten", published in 1948. It is a work of a much more advanced character, suitable for honours and postgraduate students. The subject is dealt with against a theoretical background of geochemistry, crystal chemistry and physical chemistry. The fact that it has been prepared by Niggli's colleague, Prof. R. L. Parker, is sufficient guarantee of the adequacy of

the translation, which, however, is not literal; but an English version of the original into which has been introduced a certain amount of new material, especially in the sections on crystal chemistry and classification. On the other hand, some sections of the original have been shortened, and the section on geophysics has been omitted on the ground that it has been treated more fully in recent publications in the English language.

The publishers are to be congratulated on the high quality of the printing, paper and binding used in the production of these two books; but it is regrettable that the price is likely to put one, and perhaps both, somewhat beyond the reach of the average university student.

BILE PIGMENTS

Biology of Bile Pigments, including a Review of their Chemistry and a Discussion of Analytical Methods

By Torben K. With. Pp. xiii+523. (Copenhagen: Arne Frost-Hansen, 1954.) 50 kronor.

DURING the past five years there have been published no less than five monographs dealing either exclusively or in substantial part with the bile pigments. The latest of these, "The Biology of the Bile Pigments", is a monumental treatise which contains an account, often in great detail, of most of the major work published on the subject between 1800 and 1953. The result is a valuable book of reference, which, though indispensable to all workers concerned directly with this field, is unlikely to appeal to a wider circle of readers. To the specialist, the list of references, complete with full titles and numbering well over two thousand, will be especially welcome.

The presentation of the subject-matter is very uneven. Some chapters, such as those dealing with jaundice and with the comparative biology and biological significance of bile pigments, are excellent and contain much information of interest not readily available from any other source. The author discusses in detail the earlier view that bile constituents may be secreted into lymph, and presents an excellent case for regarding parenchymatous and obstructive jaundice as lymphogenous in nature. The use of the term 'retention jaundice', however, to cover conditions in which the liver cells are damaged and unable to secrete bilirubin without any associated secretion into the lymph, is likely to cause confusion. According to the more generally known classification of Rich, retention jaundice would be the same as Witt's production jaundice and may be hemolytic in origin or of the type found in hereditary non-hemolytic jaundice. It is a pity, therefore, that the author has not seen fit to integrate his new classification within one or other of the earlier schemes of the mechanism of jaundice. The experimental work leading to our theories of the detailed mechanism of the different forms of jaundice is well reviewed and rightly emphasizes that our knowledge in this field is far from complete. The last chapter is full of useful information regarding the occurrence of bile pigments in lower animals and plants and suggests that much might be learned from a more intensive investigation of their fate in species other than the higher mammals. One agrees with the author that much valuable information might accrue from further

studies of bile pigment metabolism in the horse, a species in which urobilinoids are present in the faeces, yet in which the bile apparently contains no bilirubin.

Much of the earlier experimental results concerning amounts of the various bile pigments in the body fluids and excretions might with advantage have been condensed into a table and in some cases omitted altogether except perhaps from the list of references; all too frequently the earlier work was carried out with inadequate methods, and certainly in the case of the urobilinoids the substances were estimated without a pure preparation available as standard. Although Dr. With rightly criticizes these techniques, he still presents the results obtained by them.

The van den Bergh reaction is dealt with in remarkable detail, and although the precise proportions, amounts and concentrations of the various reagents which have been used are important in facilitating a correlation with the result obtained, the thirty-odd pages devoted to this subject make heavy reading, especially with so much in small type. The impartial presentation of the results of various workers sometimes introduces unintentional contradictions. For example, on p. 156 Kitchling and Kuhn are quoted as showing that strong solutions of bilirubin after treatment with the diazo reagent do not follow Beer's Law because of insufficiency of reagent; on the other hand, three pages later there is an account of the work of Bungenburg de Jong, who has shown that the reagent is in good excess. Dr. With's accounts of the research of the last worker are especially valuable to the English reader, for they were mainly published in Dutch or German.

Seven addenda bring the subject-matter up to date and deal with the major works published between 1951 and 1953. One of these has a useful account of Hanson's *in vivo* work on rat livers, with fluorescence microscopy and uranin as an indicator for the biliary tracts. This is interesting work, but Dr. With doubts whether the distribution of uranin is likely to be the same as that of bilirubin. Another of these addenda describes work by Bourrillon, a member of the Polonovski school. This was published as a thesis and has not been generally available. Bourrillon has disproved the view of this group that the direct diazo reaction of certain sera was due to linkage of the bilirubin with globin. The work of Cole and Lathe, who have demonstrated by reversed phase partition chromatography the existence of two polar pigments which give direct diazo reactions, has been adequately summarized and discussed in a page inserted after binding was complete.

This monograph was originally intended to be printed in the United States; but its length prevented this and it has been produced by a Danish publisher in mimeograph on one side of crown quarto pages. The resulting volume, bound simply between boards which measure eleven and a half inches by eight inches, is two and a quarter inches thick, weighs six pounds and is not very manageable. The author's English is excellent, although its phraseology is sometimes quaint; there are innumerable typing errors—no doubt due to a non-English proof reader—but at no point is there ambiguity or obscurity. The figures have been moderately well reproduced and mostly tend to illustrate some of Dr. With's own research. Presumably because of the form of publication, it has not been possible to illustrate some subjects which would have been better understood

with a figure—for example, the work on the biosynthesis of the porphyrins. The large pages crowded with type, often small, make for difficult continued reading. The book is not intended for the general reader; it is essentially a book of reference for specialist workers, and for them Dr. With has performed a signal service. C. H. GRAY

ECOLOGY OF FRESHWATER MOLLUSCS

An Introduction to Molluscan Ecology

Distribution and Population Studies of Fresh-water Molluscs. By Dr. Alan Mozley. Pp. x + 72. (London: H. K. Lewis and Co., Ltd., 1954.) 9s. net.

THIS slender volume forms the fourth in a series by Dr. A. Mozley on freshwater molluscs, their ecology, control and relation to mankind. In some parts of the world certain species of water snails carry the larval stages of the parasites responsible for the dangerous diseases, urinary and intestinal schistosomiasis, affecting 5 per cent of the human race, and others convey the parasite causing liver rot in sheep; but not all water snails are harmful, and Dr. Mozley is here concerned with the ecology of freshwater molluscs in general. As an authority on schistosome-carrying snails, he is naturally most interested in harmful species; but his experience in Siberia, Africa, Finland and Canada has enabled him to produce a little book packed with useful information and provocative thought on both harmful and harmless species.

In seven chapters he deals with limiting factors in distribution, living conditions, representative populations, dangerous localities, local economy, practical considerations and conclusions. There is also an appendix of four sections, explaining scientific details and methods of work for non-scientific readers. The index is adequate. Fourteen beautiful illustrations, chiefly of lake habitats, are scattered through the text; but unfortunately there is no picture of the snails, and a plate of the chief carriers, such as *Physopsis*, *Biomphalaria* and *Lymnaea truncatula*, would have been helpful.

Dr. Mozley is optimistic that schistosomiasis could be brought under control, since the molluscan hosts are "highly sensitive to conditions in the place in which they live", are a menace chiefly in suburban areas and where dense local populations of snails and humans occur, and can be killed, with their parasites, by treatment with copper sulphate at monthly intervals.

Throughout the book one is reminded of the problem of malaria, and of the importance of Sir Malcolm Watson's insistence on "species sanitation". As in malaria control, the problem is a local one, and it demands first and foremost an accurate knowledge of freshwater snails, their habits and habitats. Beyond that, persistence, planning and foresight are needed. Much good work is being done in Egypt under Dr. A. Halawani, director of the Fouad I Institute of Research and Hospital for Tropical Diseases, Cairo. But man in his ignorance and carelessness has brought about a spread of the disease through the Rhodesias to South Africa, and it is still extending its range. "If preventable, why not prevented?" Dr. Mozley's final words are: "There is work to be done". N. B. EALES

INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY

THE United Kingdom Government has accepted the invitation which was extended by the United Nations to eighty-four countries to participate in a conference on the peaceful uses of atomic energy, to open in Geneva on August 8 under the presidency of Dr. H. J. Bhabha, director of the Tata Institute of Fundamental Research, Bombay, and secretary of the Indian Atomic Energy Commission. Prof. W. G. Whitman, head of the Department of Chemical Engineering in the Massachusetts Institute of Technology, will be secretary-general of the conference, and in this capacity will serve as an officer of the U.N. Secretariat, assisted by a working party consisting of Ralph J. Bunche and Ilya S. Tchernychev (U.N. Under-Secretaries) and Dr. Gunnar Randers (special consultant to the Secretary-General, Dag Hammarskjöld, in matters relating to the conference).

The conference, which is an outcome of proposals laid before the United Nations by President Eisenhower in December 1953 when he urged the need for international co-operation to apply the benefits of atomic energy to world peace, will be devoted to the presentation and discussion of papers on a number of main subjects related to the peaceful uses of atomic energy (see preliminary announcement, *Nature*, February 19, p. 328). It is intended that subjects will be dealt with and presented only from the scientific and technical points of view.

The United Kingdom Papers Committee, which has been set up under the chairmanship of Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell, to integrate the United Kingdom's contribution to the conference, has drawn up a provisional list of papers and authors covering the majority of topics to be discussed. The Committee will be pleased to receive suggestions for titles and authors of additional papers, and communications should be addressed to the Secretary of the Papers Committee. Abstracts not exceeding five hundred words in length must be submitted to the Papers Committee on or before May 1, and the completed papers must be submitted on or before June 15.

The constitution of the U.K. Papers Committee is as follows: Sir John Cockcroft (chairman); Sir George Thomson (Royal Society); Dr. G. H. Daniel (Ministry of Fuel and Power); Dr. J. F. Loutit (Medical Research Council and Agricultural Research Council); Mr. P. Dankwerts (Industrial Group, Atomic Energy Authority); Mr. J. A. Jukes (Atomic Energy Authority); Dr. B. F. J. Schonland, Dr. J. V. Dunworth, Dr. R. Spence, and Dr. J. Gaunt (secretary) (Atomic Energy Research Establishment, Harwell).

It is unlikely that time will permit more than a small fraction of papers to be presented verbally; but all accepted papers will be published in the proceedings of the conference. Owing to shortage of accommodation, it is not certain that authors of papers will be able to attend all the sessions of the conference, even if their paper is accepted for verbal presentation. The final choice of papers will lie with the United Nations Advisory Committee, which is responsible for advising on conference arrangements.

The United Kingdom Government will contribute to the exhibition to be held in Geneva during the

conference, and full details regarding it will be announced at a later date.

The plenary sessions of the conference will cover the following topics: (A) and (B), need for a new power source; (C), the role of nuclear energy; (D), the building of a nuclear energy enterprise; (E), health and safety aspects of nuclear energy; (F), production and use of isotopes, and problems relating to large quantities of radioactive substances. The sessions dealing with the need for a new power source will include survey papers on estimated world-power requirements in 1975 and 2000, on the alternative sources of power, and on the needs of individual countries for power and heat. Session C will include survey papers on the natural occurrence of uranium and thorium; each nation is being invited to furnish all available data, and the conference organization will make a summary of papers submitted, a few of which will be selected for presentation. Session D will deal with the capital investment required for the development of nuclear energy and will include experience with existing plants. Session E will consider the biological effects of radiation, including a discussion of human exposures which have occurred and the results of animal experiments, ecological problems arising from selective destruction of a given species in the food web, and the location of power reactors, with special consideration to the widespread dispersal of fission products. Session F will include survey papers on the use of isotopes in science and industry, and also on the problems of long-term storage and disposal. Session G will be concerned with what may be termed the present state of the art of handling large quantities of radioisotopes and the administrative and legal problems arising in the use of high-level radiation sources; this covers such matters as the training of industrial personnel, industrial safety, workman's compensation, etc.

In addition to the plenary sessions, there will be more specialized meetings devoted to specific topics. Under the heading of reactors, the programme mentions research reactors, power reactors including survey papers on fuel cycles and types of reactor, fast neutron reactors, thermal neutron reactors, and details of the running of prototypes of power reactors.

Sessions on technology are expected to cover such subjects as methods of prospecting for uranium and thorium, chemical treatment of the ores, production of uranium and thorium metal, analytical methods and the production technology of special materials such as heavy water, zirconium, beryllium and its oxide, and graphite. It is also hoped to have survey papers on chemical aspects of nuclear reactors, chemical processing of irradiated uranium and thorium fuel elements and the storage and separation of fission products. Other subjects included under the general heading of technology include the metallurgy of thorium, uranium and their alloys, fabrication of fuel elements, technology of liquid metals and the treatment and disposal of waste.

Reactor physics sessions will deal with equipment and techniques used in measuring cross-sections important for reactor design and the results obtained; selected topics such as neutron decay, certain (n, γ)

or (γ, n) reactions, fission, γ -ray spectrum in fission, measurement of such quantities as the number of neutrons per fission, diffusion length, slowing-down length, transport mean free path and resonance integrals; zero energy, exponential and critical (or model) experiments; reactor calculation techniques and comparison with experiment.

Sessions on reactor chemistry and metallurgy are expected to have survey papers on the fission process and the chemistry of its products, and the chemistry of the heavy elements, especially plutonium and neptunium. The problems involved in studying chemical reactions using highly radioactive materials, and the effects of radiation on materials used in reactors and also on solutions and metals, alloys and semiconductors, are also to be considered.

The biological and medical sessions will deal with such topics as the use of nuclear energy in medicine, for example, for diagnosis, therapy or tracer techniques, and in special public health problems such as the epidemiology of communicable disease, and the availability of rare elements in human nutrition. Genetic effects will also be considered in these sessions, covering both botany and zoology. Sessions will also be devoted to the biochemical and physiological uses of radioactive isotopes; use of nuclear energy in special problems of agriculture and forestry concerning plant genetics, movement of plant nutrients, pests, etc.; environmental mechanisms; and public health, including biological cycles of fission products in land and water organisms.

The topics to be considered in the sessions on the applications of radioisotopes to research and industrial problems include tracers in general research, developments in dosimetry, instrumentation and remote controls, applications of isotopes in process and quality control, and industrial utilization of fission products.

In addition to the specialized papers in the various sessions referred to, there will be a number of evening sessions at which leading men of science will deliver lectures of a more general character; the topics to be discussed will be accelerators for particles, elementary particles, nuclear forces, nuclear structure, the neutron, isotopic dating, uses of radioactive substances in biology and medicine, free radicals and new elements.

EMIL BEHRING AND PAUL EHRlich*

THEIR CONTRIBUTIONS TO SCIENCE

By PROF. C. H. BROWNING, F.R.S.

Emeritus Professor of Bacteriology, University of Glasgow

Cancer Research

THE first results of Ehrlich's cancer investigations, which started late in 1901, were to demonstrate on an extensive scale the general impossibility of establishing tumours of one animal species in others. He also set about obtaining, in addition to Jensen's tumour, a series of transplantable tumours in mice which should be available for study. By giving a twenty-mark piece for every animal bearing a spontaneous tumour a large number were collected; the majority arose from the mammary gland in old

*Continued from p. 575.

female mice. Subcutaneous grafting in fresh animals established numerous strains, although very many failed to grow. On the analogy of infections, their 'virulence' increased on passage in the sense of the proportion of takes and the rate of growth. A minute study of their biology and structure indicated that the initial survival and subsequent growth of a fresh graft were closely associated with the angiotactic effect on the host's blood vessels. The microscopic structure depended considerably on the rate of growth. In addition to carcinomas, other classes of tumour were also propagated, for example chondro- and osteo-sarcomas. A remarkable observation was the development of sarcoma in a strain of carcinoma and thereafter the successful separation of the two malignant components. The origin of the mixed tumour was attributed to some chemical effect of the carcinoma cells on those of the stroma. At the time, little was known of chemical carcinogens; but later observations presented the picture of what may be a closely analogous phenomenon. This was the production of sarcoma in mice from a phagocytic tissue which had developed in response to particles of a styryl quinoline compound resulting from precipitation of the dye in the tissues by the lymph*. Ehrlich approached the problem of acquired resistance to tumours by inoculating mice with a spontaneous tumour of negligible virulence; after 8-14 days, upwards of 50 per cent of the treated animals had become refractory to grafting with a highly virulent tumour, and this state lasted for some weeks or months. Normal tissues produced a similar effect. In spite of many interesting findings, the mechanism of acquired resistance to tumours still remains obscure, however.

The influence of nutritional factors on tumour growth interested Ehrlich deeply. He observed that a mouse tumour inoculated into rats grew vigorously for several weeks, but then receded; also transplants from the original rat to other rats failed to grow. On the other hand, the tumour could be maintained by alternate passages from rat to mouse. The conclusion drawn was that some nutritive material essential for growth is present in mice, but not in rats; hence the resistance of the latter was termed athrepsy. A number of other phenomena were also classed as athreptic; but so far the conception has not proved fruitful for tumour pathology in general. The results of experiments on the chemotherapy of tumours were not published.

Chemotherapy

In 1891 Ehrlich, with Guttman, published encouraging results in the treatment of malaria with methylene blue. From 1904 onward he concerned himself chiefly with chemotherapy. This work makes great demands on aptitude, patience, and material resources, as well as luck (the '4 G's'—from the initials of the German words). His reputation as a scientist stood very high, and Frau Franziska Speyer, in memory of her husband, provided for the building and endowment of the Georg Speyer-Haus, to be devoted to research on chemotherapy, with facilities both for biological and chemical workers. When it started in 1906 there were three chemists and two biologists; soon the numbers increased. Already a very significant success had been achieved with trypan red, which in a single dose sterilized mice severely infected with *T. equinum*, the trypanosome responsible for a disease of horses in South America.

The infection in mice assumed a septicæmic form and was invariably fatal in a few days in untreated animals; no other cure was known. The drug was found as the result of trying the effect of a large number of available dyes, among which one of the benzopurpurine series showed slight action. It was poorly soluble, and Ehrlich concluded that slow absorption from the site of injection might impede its action. Accordingly, a series of related compounds was prepared for Ehrlich in the laboratories of his friend, A. v. Weinberg (firm of Cassella); trypan red was the best of these. However, it did not act on *T. brucei*, which is closely related to *T. gambiense*, the cause of African sleeping sickness.

Drugs moderately effective against *T. brucei* were found in the triphenylmethane series, etc.; also, French workers noted that trypan blue, related to trypan red, acted; but these showed no great prospect of chemical development. At this time, Thomas, of the Liverpool School, directed attention to the therapeutic action in trypanosomiasis of the arsenical atoxyl, which Ehrlich had previously discarded, since the strain of trypanosomes then tested was insensitive. He confirmed its therapeutic property and in his hands it proved the starting point for synthesis of a very large series of organic arsenicals, among which was the famous salvarsan. This drug, in addition to being trypanocidal, acted also on various spirochætal infections, including relapsing fever and syphilis. In this disease in man its efficacy enormously transcended that of mercurials, the folk remedy. Ehrlich, from being a scientist of international reputation, became a world celebrity. At the same time, he fell a victim to worries which had not previously threatened his work. For example, in the air salvarsan is readily oxidized to very toxic products; for this reason it was dispensed in single doses in sealed tubes from which air was removed. Also, precise instructions were issued for preparation of the solution in sterile distilled water, neutralization and intravenous injection without delay. Instead of the directions being followed, the drug was often kept for long periods before administration or used when only partially dissolved, or infected water employed. The resulting disasters received wide publicity and Ehrlich was blamed.

In the chemotherapy of experimental trypanosomiasis, the chief phenomena of 'therapeutic biology' were discovered in Ehrlich's laboratory. These are as follows. (1) Variations in therapeutic response as measured by the ratio of the curative dose to the maximum well-tolerated dose. Determining factors are the host's species and individuality, also the parasite's species and strain (including its past history). (2) Immunity reactions of the host during treatment frequently are a factor in cure. (3) Alterations in antigenic constitution of the parasite occur when the course of the infection is a relapsing or a chronic one; new antigens replace the old ones or may become superadded. This is a serious obstacle to effective treatment; because there is, as a rule, little or no cross-immunity between strains of the same species. Such changes may be produced at will, for example in *T. brucei*, by adding a sublethal dose of the antiserum to the parasites *in vitro* and then injecting them into a fresh animal. The parasites of the resulting infection have acquired fresh antigens, that is, a serum-fast (or relapse) strain has developed. The only certainty of maintaining a strain unaltered in its antigens exists where the parasites multiply progressively and become abundant

in the blood within a few days after inoculation; at this point, the same of the infection, they must be transferred to a fresh susceptible animal of the same species and the procedure repeated indefinitely. (4) Acquired drug-resistance may result where treatment fails to cure and relapses are treated with the same drug. Finally, there is no therapeutic response, and when the parasites are transferred to fresh animals the infection resists maximal doses of the same drug. Such drug-resistant strains are, of course, also relapse strains. But drug-resistance can be developed without antigenic change by treatment in successive passages with doses too small to retard the acute course of the infection. Contact of parasites and drug *in vitro* between successive passages may also lead to a drug-resistant strain. Whether acquired drug-resistance is a mutation or an adaptation remains unsettled. Where it develops only very slowly the question would appear to be largely one of definition. (5) Therapeutic interference (known to Ehrlich from 1907, but not published until 1922) consists in one trypanocidal drug (parafuchsan) preventing or reducing the therapeutic action of another (trypanflavin). Other examples of such interference are now known; and a form of biological interference between viruses has of late attracted attention. The mechanism of therapeutic interference is obscure; it is not connected with acquired drug-fastness. For the original case, Albert has suggested that the two substances form mixed micelles.

Later investigations on other infections have not added anything important to the phenomena of therapeutic biology discovered in connexion with trypanosomiasis.

As to the mechanism of action of trypanocidal drugs, practically all the evidence points to their damaging the vitality of the organisms either directly or by derivatives formed in the body. Thus, in the case of the aromatic arsenicals, while the pentavalent arsenic acid compounds (atoxyl series) are almost innocuous to the trypanosomes *in vitro* and the trivalent arsenobenzole (for example, salvarsan) is not very toxic, the corresponding trivalent arsenoso compound or arsenoxide (mapharside) is a most potent poison. There is also experimental evidence that the pentavalent form yields the arsenoxide *in vivo*; therefore, most probably this is the active substance in the body. Ehrlich originally chose the arsenobenzole for therapy on account of the high toxicity of the arsenoxide for mammals; but it is not certain if this preference was fully justified. He postulated the fixation of the haptophore group of the drug by receptors of the parasites (chemoceptors). The fact that drug-resistant strains fix less of the drug than susceptible strains is strong evidence for this. Resistance would thus be due to a lessened affinity for the drug from loss or diminution of the corresponding chemoceptors by the organisms and not to increased tolerance. Ehrlich found that atoxyl-fast trypanosomes were susceptible to a certain drug of the arsenobenzole class, arsenophenylglycine, but could be rendered resistant to the latter also. Therefore, he supposed that the acid side-chain which this compound possesses must act as a second haptophore and so increase its affinity for the organisms.

King, however, has recently brought evidence which emphasizes the influence of physical-chemical factors. He found that the corresponding arsenic acid also acted on an atoxyl-fast strain *in vivo*. Accordingly, he studied the action of a series of the

arsenoxides on the trypanosomes *in vitro* and correlated the results with the physical-chemical behaviour of the compounds. The following were salient findings: the arsenoxide of arsenophenylglycine, which is highly ionized and will travel in water, also phenyl arsenoxide which lacks a hydrophilic group apart from the arsenical and so will travel at a lipid-water interface with phenyl in the lipid, both act equally on normal and on atoxyl-fast strains. On the other hand, the arsenoxides of atoxyl, its acetyl derivative, etc., which act much more strongly on normal than on atoxyl-fast parasites, are probably substantive for certain chemically polar constituents which fix trypanflavin, since resistance to trypanflavin and to arsenicals of the atoxyl type is identical. King concludes that there is no evidence that differences in chemical reactivity among these various arsenicals exist and so play a determining part. In all probability, therefore, the substances differ in the first phase of their action, and the ultimate nature of the arsenic receptor is unknown. Ehrlich suggested that the effect of arsenic might be exerted on sulphhydryl groups of protoplasm; and Voegtlin *et al.* showed that glutathione neutralized the trypanocidal action of trivalent arsenicals both *in vivo* and *in vitro*. But no further clarification has been possible and no chemoreceptors have been identified chemically.

Ehrlich thought of the molecule of a chemotherapeutic agent as being like a toxin, provided with a toxophore group, as well as a haptophore, but did not particularize further. His aim was to increase the 'parasitotropic' properties of drugs, while diminishing the 'organotropic' or, in other words, to find substances with selective toxicity. Nowadays, when the importance of enzymes for vital processes has become prominent, it has been suggested that the drug dislocates such processes. One way in which this may occur is by introducing an imitation or perversion, so to speak, of an essential substance, which is accepted by the parasite and incorporated in its metabolic apparatus, and so blocks the action of some enzyme. This shifts the problem to 'first find your enzyme', which so far has proved a very difficult one. Another recent suggestion is that some drugs act as chelating agents and so deprive the parasites of essential trace metals. This would be a form of Ehrlich's athrepsy; and it is known that the multiplication of *Pl. berghes* and *T. congolense* can be prevented by diets which sustain the life of the host.

The chemotherapy of spirochaete infections was closely associated with that of trypanosomiasis. *Spirillum minus*, a small non-pathogenic organism found in mice, was investigated and found to be refractory to most known trypanocidal drugs, but susceptible to salvarsan. With this lead the anti-syphilitic property was discovered. With *Tr. pallidum* there was little evidence that acquired resistance to arsenical drugs would be a serious danger. As an anti-syphilitic, salvarsan has now been superseded, at least temporarily, by penicillin, which is much less poisonous. It is of interest that penicillin has no trypanocidal action. The relapsing fever spirochaetes also are often susceptible to salvarsan; but resistant strains are met with. Such an occurrence raises the question whether a drug-fast strain has been produced by treatment in the field, and this problem arises in connexion with trypanosomiasis also. But it must be borne in mind that mass treatment may eradicate the susceptible

infections and so lead to an apparent increase of cases harbouring less susceptible strains. There is ample evidence that such "ferox" strains, as Ehrlich called them, arise independently of specific treatment. The leptospiroses are unsusceptible to known chemotherapeutic agents. He was not very hopeful about the prospect of finding chemotherapeutic agents for systemic bacterial infections, and it is strange to recall that the synthesis of sulphanilamide was published in 1908.

Ehrlich's method in the contrivance of chemotherapeutic drugs was first to find by trial a compound showing some degree of the desired action, and then to prepare structural variants with the view of decreasing toxicity for the host, while relatively increasing that for the parasite. Accumulated experience has now furnished much information on the likely effects of introducing substituent groups into the molecule of such drugs, but generalizations of wide applicability are still not numerous. In the absence of a far deeper knowledge of the biochemical differences between the metabolism of hosts and parasites, this has so far proved the most promising approach. A more rational, planned attack on the problem would require meanwhile, as King has aptly put it, the co-operation of agents with powers like those of Clerk Maxwell's "demons". What would be the position of chemotherapy to-day without Ehrlich? He alone in his time had the profound knowledge both of biology and chemistry, as well as the enterprise, to apply chemical means to the attainment of purely biological ends. He seemed to sense the presence of a rich treasure where no one else suspected its existence. It is fairly safe to guess that without this one man a fruitful branch of pharmacology and a profitable industry, as well as an era of immense amelioration of human and animal diseases, would have been long delayed.

Chemistry

Ehrlich was continually engaged in chemical investigations. While there was, as a rule, a biological aim in view, a number resulted in valuable contributions to pure chemistry. The usual procedure was to find some chemically highly reactive compound and to explore its synthetic capabilities, especially in the direction of intensely coloured products, or else he probed the constitution of a substance by examining its behaviour with reagents which would identify the presence of particular atom-groups. His apparatus consisted merely of test-tubes, a Bunsen burner and a copious collection of compounds, reagents and solvents. But to these was brought an enormous knowledge of organic chemical literature, particularly in all that concerned dyes, their intermediates and methods of synthesis. When a lead was obtained, the help of chemical specialists was sought and he had a preference for those with experience in industry, where good yields are reckoned of importance. The following is a selection of Ehrlich's chemical work which proved of outstanding importance. The diazo reaction of urine consists in a red coloration on addition of diazotized sulphanilic acid and ammonia. A positive result is got in cases of fever, especially enteric, but not with normal urine. The reaction has been traced to bilirubin and other pyrrole compounds and has found an important application in the investigation of haemopyrroles. The dimethylaminobenzaldehyde reaction of urine is a brilliant cherry-red coloration on adding a solution of the reagent in dilute hydrochloric acid; it is given

in various febrile states and is due to the pyrrole component, in urobilinogen. A coloured product is also given with indole and is a delicate indicator for its formation in bacterial cultures. Reactions of aromatic nitroso compounds: (1) with acid chlorides highly reactive products are formed; for example, that from benzoyl chloride and nitroso-dimethylaniline along with a solution of *m*-toluylenediamine in the cold at once produces toluylene blue; (2) with reactive methylene groups; for example, nitroso-dimethylaniline and benzyl cyanide condense readily, and the product is split by mineral acid to yield benzoyl cyanide; this provides a method for obtaining ketones from the corresponding methylene compounds. Similarly, the preparation of the aliphatic triketopentane, a very powerful reducing agent, was achieved. Also the use of the reaction helped in determining the constitution of atropine and cocaine. The reaction of azonium bases with compounds containing free or substituted methylene groups yields highly coloured compounds; for example, flavindulin and deoxybenzoin produce a base the salt of which is at first blue, but on standing turns orange-red. The Ehrlich-Herter reaction with 1:2-naphthoquinone-4-sulphonic acid consists in the formation of coloured products on condensation with aromatic mono- or di-amines; a concentration of one part of aniline in one million can be detected: compounds containing reactive methylene groups (also methyl groups) produce coloured salts, which act as mordant dyes; in these the 4-sulphonic acid group has been replaced by the aromatic residue. The rhodamine dyes, also Nile blue and other oxazine dyes, were developed industrially as the result of Ehrlich's suggestions for compounds which he required for biological researches. Aromatic compounds of arsenic were prepared in considerable variety by Michaelis about thirty years before Ehrlich's work. Still earlier, Béchamp made what he took to be an anilide of arsenic acid. But the field was largely neglected, except that a sodium salt of Béchamp's compound was manufactured and placed on the market as a drug under the name of atoxyl, which was little toxic in relation to its content of arsenic. It appears that Ehrlich found atoxyl could be diazotized and so must have a free amino-group. Along with Berthelm, its constitution was established as the salt of *p*-amino-phenyl arsonic acid ($\text{NH}_2\text{C}_6\text{H}_4\text{AsO}(\text{OH})_2$). This opened up wide synthetic possibilities: according to the degree of reduction of the arsenic atom, in addition to the arsonic acid series, arsenoso (—AsO) and arseno (—As=As—) derivatives can be prepared. Some thousands of such substances have been made.

Pharmacology

Relations between the constitution of chemical compounds, their distribution in the body and action on the tissues were an abiding interest for Ehrlich and, as has been seen, most of his work involved aspects of the problem. In order to act, a substance must be fixed—its haptophore groups must find fitting receptors and then its ergophore (toxophore) groups can operate; both groups are determined by their chemical and physical characters. A number of important studies on these lines have not been dealt with so far. An early work on the passage of fluorescein into the aqueous humour after paracentesis of the anterior chamber and subcutaneous injection of the dye was significant for elucidation of the circulation of the intraocular fluids. In an investigation

of the febrifuge quinoline derivative, thallin, the distribution of the drug in the tissues was demonstrated by means of ferric chloride, with which it yields an intense green colour capable of being fixed with mercuric chloride. Thallin is stored in the fatty tissue and, as this is poorly oxygenated, the drug is preserved from oxidation. It is noteworthy that as early as 1886 Ehrlich proved the antipyretic property of the drug in sick animals—rabbits rendered febrile by infecting their skin with streptococci. He investigated staining of the central nervous system *in vivo*; it was demonstrated that generally lipotropism and neurotropism are manifested in parallel, the phenomenon being regarded as analogous to the Stas-Otto process. In enunciating the principle, Ehrlich was the forerunner of Overton and Meyer. The importance of physical factors in staining was clearly brought out by showing that an alcoholic solution of cyanin when diluted with isotonic saline does not stain the central nervous system; but when blood serum is the diluent the dye is more finely dispersed and then staining occurs. Ehrlich discovered that cocaine, in addition to its local anæsthetic action, produces a remarkable diffuse foamy degeneration of the liver cells. He therefore investigated the correlation between the two properties in a series of cocaine derivatives, and observed that the liver changes are produced by a number of the compounds which are devoid of anæsthetic action.

The above is an outline of Ehrlich's chief contributions; but much of importance has necessarily been omitted. In every field in which he worked, the facts discovered, the methods devised and the theories which he formulated are still dominant.

* Browning, C. H., Gulbransen, B., and Niven, J. S. F., *J. Path. Bact.*, 42, 155 (1936).

* Browning, C. H., *Ann. New York Acad. Sci.*, 59, 198 (1954).

THE INDIAN AGRICULTURAL RESEARCH INSTITUTE

By SIR JOHN RUSSELL, O.B.E., F.R.S.

THE Indian Agricultural Research Institute celebrated its golden jubilee during April 1-4. Its foundation in 1905 was facilitated by a gift of £30,000 by an American, Mr. Phipps, to the Viceroy, Lord Curzon, who was anxious to extend the application of science to the production of food in India. This was not a new venture. The Famine Commission of 1880 had made a beginning, and nine years later Dr. J. A. Voelcker was invited to visit India, study the problems on the spot and advise thereon; his report was very shrewd and able, though it was years before he was given the credit he deserved for it. At that time agricultural improvement was considered to be chiefly a matter for chemists, and Dr. Voelcker's assistant, J. W. Leather, was appointed to do what he could. Before long, problems arose that lay outside the realm of chemistry: sugar cane diseases were causing serious losses in Madras, and in 1898 Dr. C. A. Barber was brought over from the West Indies to deal with them. He very wisely adopted the method, not then in common use, of overcoming disease by breeding resistant varieties, and he was so successful that the whole current of Indian agricultural science set for many years in the direction of plant breeding. In 1901 another Famine Commission was set up and was able to insist more

strongly than its predecessor on the necessity for fostering agricultural research; this was fully accepted by Lord Curzon; the agricultural departments were strengthened, and Mr. Phipps's gift made possible the Central Experiment Station.

It was established at Pusa in Bihar, an interesting district at that time as much indigo was grown there and the planters were feeling the competition of the synthetic product. They had their own research organization, but it was too small, too late, and wrongly organized; the crop had to be abandoned. Pusa was better organized from the start: its staff included J. W. Leather as chemist, A. Howard and his gifted wife Gabrielle, née Matthai, both able botanists, she exceptionally good; E. J. Butler was mycologist, and M. Lefroy entomologist. All did valuable work. Leather's was perhaps the least known; it was on the water requirements of plants and on soil moisture and received less attention than it deserved. The Howards had available to them the very useful collection of wheats at the Cawnpore Experiment Station started by W. H. Moreland and extended by J. Haymon and later by Bryce C. Burt; one or both of the Howards had the artist's eye for picking out suitable parents, and before long Pusa 4 and Pusa 12 were widely and successfully grown in the United Provinces and the North West Frontier Province. The aim at the time was to produce in a bad season enough wheat to satisfy home requirements; this meant a surplus in a good season which could be exported to Britain. The plant breeders therefore had in mind the requirements of British millers. Rust-resistant linseeds and wilt-resistant pigeon peas were also bred. Breeding of sugar cane varieties was systematized at Coimbatore by C. A. Barber, and the work was continued by T. S. Venkataraman; the Station was joined with the Imperial Institute in 1931 and remained so until recently.

Pusa had several disadvantages: it was very isolated, which is always bad for the staff of a research institute, and it was not exempt from earthquakes. One came in 1934 and damaged the main building beyond repair. It was wisely decided to transfer the Institute to a site near New Delhi. A thousand acres of land was acquired and some very fine laboratories were set up: the new Institute was opened in November 1936 by the Viceroy, Lord Linlithgow. The ceremony was unforgettable; I was among the guests, and kept in touch with the Institute in after-years; on my last visit four years ago it was a great pleasure to see how well the high hopes expressed on that opening day had been fulfilled.

The present director, Dr. B. P. Pal, has done valuable work in breeding wheats resistant to rust and loose smut. India's wheat belt is in the north, but as rust is worst in the hills Dr. Pal has bred varieties suitable for use there. All three rusts occur—black, yellow and brown; varieties showing good field resistance to each have been produced, but none is yet resistant to all three. Varieties of potatoes resistant to late blight have been produced. The entomological staff is making some interesting investigations on the biological control of insect pests. Good work on soil colloids was done by the previous director, J. N. Mukherjee; the well-known Soils Department is in charge of S. P. Raychaudhuri. In the Agronomy Department under T. J. Mirchandani a good dairy herd has been built up, giving an average milk yield of 600 gallons per lactation—which is far in excess of the usual quantity in India.

Co-operative fertilizer trials in different parts of India are also made.

The Institute's agricultural extension work in the Delhi villages promises to yield valuable results; India's great problem hitherto has been to get the peasants to adopt the improvements devised at the experiment stations. It has not been entirely a matter of ignorance: there have been serious practical difficulties which this extension work will reveal and ultimately, it is hoped, overcome.

A valuable feature of the work from the outset has been the training of postgraduate students to fill the numerous posts created by the Planning Commission and other development organizations. A hostel has been built to accommodate a hundred of them.

The contributions of Indian scientific workers to the advancement of their respective subjects are not so well known outside India as they should be, and it is very desirable that steps should be taken to summarize them in easily accessible monographs. A beginning was made in 1949, when Dr. P. E. Lander, formerly principal of the Punjab Agricultural College, produced "The Feeding of Farm Animals in India"; this was followed by "Dairying in India", by J. N. Warner, of the Allahabad Agricultural Institute, and by "Animal Nutrition Research in India", by Dr. K. C. Sen, director of the Indian Dairy Research Institute at Bangalore.

The Institute has a great record of valuable service rendered to agricultural science in general and to India in particular: a record of which its members can be justifiably proud. It has an able and enthusiastic staff, and all their colleagues and friends elsewhere will wish them a happy and prosperous future.

OBITUARIES

Sir Godfrey Thomson

By the death of Sir Godfrey Thomson at Edinburgh on February 9, education and educational psychology have suffered the loss of an outstandingly vivid personality.

Born in Cumberland in 1881 and educated from early years at Newcastle, Godfrey Hilton Thomson to the end of his life was recognizably of that part of England that lies between Tyne and Tweed. At Armstrong College (now King's College), Newcastle upon Tyne, he graduated B.Sc. with distinction in mathematics and physics, a postgraduate fellowship allowing him to study at Strassburg under Ferdinand Braun and gain a doctorate in physical science. There his natural talent for geometry also found inspiration from K. T. Reye; but for certain turns of circumstance he might well have become a geometer. As it was, the Queen's Scholarship upon which he had entered Armstrong College exerted a long-range effect, since one of its provisions had been that the holder should teach for a number of years. Thus Thomson became an assistant lecturer in education in his old College, an experience which, together with earlier experience as a pupil teacher, gradually transferred his interests towards the psychology of education. This transition is marked by some papers dealing with psychophysical methods. A long vacation spent in the laboratory of C. S. Myers at Cambridge and some statistical contact with Karl Pearson played a further part in fixing the lines of his career. In later life he claimed to be a Peas-

sonian; perhaps Aristotelian might have been the more exact description.

It is probable that his final orientation was determined at the time, and by the occasion, of the well-known controversy, now almost forty years old and somewhat outdated, between him and C. Spearman, concerning the latter's theory of the general and the specific factors that enter into mental ability and are presumed to explain certain properties of the correlation tables derived from test scores. Thomson's own theory, antithetical to Spearman's, was a many-factor sampling theory; but he always preserved a mind open to various later explanations. His mature views are to be found in his book, "The Factorial Analysis of Human Ability", published in 1939.

In 1920 Thomson was appointed to the chair of education at Newcastle, a post which he held for five years, one session being spent in America, where he was always *persona gratissima*. It was during these years that he devised the Northumberland Tests, designed to select children for the advantages of free secondary education. His motive here, as always, was the securing of justice for all classes of the community.

In 1925 he was appointed professor of education in the University of Edinburgh and director of Moray House Training College, an arduous double office which he held until his retirement in 1951. It is remarkable that in spite of the exorbitant demands of administration and of numberless extraneous committees, he still found time to write papers and books. During this period the Northumberland Tests evolved into the Moray House Tests. Characteristically, he refused to accept personal benefit from these, establishing a trust which administered the proceeds towards educational research.

In the two great surveys, in 1932 and 1947, of the intelligence of a complete age-group of all Scottish children, with sociological and other implications, Thomson was chairman of the Mental Survey Committee. Many other chairmanships and secretaryships, of the Committee of Sociology under the Colonial Research Council, of the Twelfth International Congress of Psychology, the British Psychological Society, the Psychology Section of the British Association and so on, make it very apparent that Thomson, a man of pre-eminent public spirit, never spared himself.

A knighthood was conferred upon him in 1949, the culmination of many distinctions. These were worn so lightly that in his presence they were forgotten. Both personally and as an educationist he was known and respected throughout the world; tall, spare-built, alert of glance and quick of speech; forthright, endlessly generous and sympathetic. His work remains and will be remembered; but still more one will remember the man.

A. C. ATKIN

Prof. C. O. Bannister

By the death on February 22 of Charles Olden Bannister, professor emeritus of metallurgy in the University of Liverpool, at the age of seventy-eight, the teaching and practice of metallurgy loses one of its few remaining links with the closing years of the past century, when such far-reaching changes were taking place in regard to what should constitute the curricula of courses for students in that branch of technology. In fact, metallurgy, as a subject, apart from the operations of smelting and recovery, was

only just beginning to be recognized as an essential adjunct to successful engineering practice. In this rapidly widening conception of what metallurgy should stand for, Bannister had played a distinguished part.

With a sound basis of practical chemistry before going to the Royal College of Science in 1896, he had there the unique advantage of coming under the direct tutelage of Prof. W. A. Tilden and a brilliant group of lecturers and demonstrators which included William Palmer Wynne, Martin O. Forster and J. S. S. Brame, all of whom achieved distinction in wider fields in later years. Electing to take the associateship of the Royal School of Mines in metallurgy, Bannister then came under the inspiring influence of Roberts-Austen, whose teaching and researches had already pointed the way to the future scope of metallurgy. After heading the list in his year (1899), with the award of the Bessemer Medal, he remained at the School as an instructor in assaying, first under the professorship of Roberts-Austen (until his death in 1902) and then under his successor, Prof. William Gowland. During this period, when he was closely associated with the late W. H. Merrett, he received the postgraduate award of an 'honours' associateship. Then, in 1903, the opportunity came to transfer his activities to the City of London where, a few years previously, the considerable enlargement of a very old city foundation in Aldgate had led to the creation of the Sir John Cass Technical Institute. There, as head of the Metallurgical Department, Bannister built up, during the next sixteen years, what became an outstanding school of metallurgy in the Metropolis.

During his tenure of this post Bannister was also closely associated, as a consultant in Westminster, with the late F. W. Harbord (a School of Mines man of an earlier generation) and with the late E. F. Law (one of his own fellow-students). This association brought him into intimate contact with the varied metallurgical problems with which practising engineers were being confronted in those days, when there were but few to whom they could turn for help and advice. During the First World War (1914-18) Bannister was responsible for a variety of work for the British and Belgian Governments, and he also served as a war-time lecturer at the Royal School of Mines. Then, in 1920, came his appointment as the first occupant of the chair of metallurgy in the University of Liverpool, which he continued to hold with distinction until his retirement in 1941. The Department of Metallurgy was, at that time, unique in being within the Faculty of Engineering. This ensured that its students received tuition both in mechanical and electrical engineering. Moreover, Prof. Bannister arranged that all engineering students should attend courses in metallurgy, particularly of iron and steel. Courses were arranged for naval architects and marine engineers to cover matters such as corrosion and the metallurgy of bearing metals. From time to time he was called as an expert witness in law cases of importance and at times in association with Horatio Ballantyne. During the tenure of his professorship at Liverpool, he had been dean of the Faculty of Engineering from 1924 until 1928 and again from 1935 until 1938.

Bannister undertook to revise, in step with rapid progress, certain metallurgical text-books having an established prestige—Gowland's "Metallurgy of the Non-Ferrous Metals", Sexton's "Metallurgy" and Lunge and Kean's "Technical Methods of Chemical Analysis". He was also the co-author, with H. Garland, of "Ancient Egyptian Metallurgy", and he

also wrote of ancient bronze implements (see *Nature*, 116, 786; 1925).

Prof. Bannister was a member of many technical institutions and societies—to which he had made numerous contributions—such as the Institution of Mining and Metallurgy, the Iron and Steel Institute, the Institute of Metals (of which he was an original member), the Society of Chemical Industry, and the Liverpool Engineering Society. He was a Fellow of the Royal Institute of Chemistry. Of his many awards, his early successes at the School of Mines have already been mentioned. The Edward Matthey Prize for research followed in 1902, and in 1903 he became a Carnegie Scholar of the Iron and Steel Institute, while in 1912 he was awarded the Consolidated Goldfields of South Africa Gold Medal by

the Institution of Mining and Metallurgy, and in 1919 the Bessemer Premium of the Society of Engineers.

Those of us who had enjoyed his friendship from the very early days at South Kensington have always had happy memories of his ever-cheerful outlook and genial personality and a great admiration for his work, both as a teacher and as a practitioner. In these spheres his approach was always characterized by a quickness off the mark and by a directness which left no doubt that he had clearly grasped the essentials of any problem or situation with which he might be faced. His judgments were both shrewd and sure.

Prof. Bannister is survived by his widow, a daughter and a son.
S. W. SMITH

NEWS and VIEWS

Physical Chemistry at King's College, London :

Sir Eric Rideal, M.B.E., F.R.S.

SIR ERIC RIDEAL retires at the end of the present session from the chair of chemistry in the University of London which he holds at King's College. He succeeded the late Prof. A. J. Allmand in 1950. During his tenure of office, Sir Eric has materially strengthened the interests of physical chemistry at King's College, particularly at the postgraduate level. His wisdom and wide experience have also been drawn upon in matters beyond chemistry, and although his period in office has been short he has nevertheless brought great benefit and distinction to the College in many ways. He will leave behind many friends. His earlier associations with the University of Cambridge and later with the Royal Institution, as well as his scientific contributions to colloid science and surface chemistry, are well known. His retirement removes from the sphere of academic chemistry one whose scientific work has attained international recognition. The subject of colloid science which he did so much to create and develop will be carried on very largely by the great number of physical chemists throughout the world who had the privilege of working under his direction and inspiration. During the past five years, Sir Eric has also held numerous other offices, including those of president of the Chemical Society and chairman of the Advisory Council on Scientific Research and Technical Development of the Ministry of Supply.

Prof. D. W. G. Style

DR. D. W. G. STYLE, who has been appointed to succeed Sir Eric Rideal, was educated at Epsom College and King's College, London. He worked under the late Prof. A. J. Allmand and afterwards under Prof. M. Polanyi at the Kaiser Wilhelm Institut, Berlin. Since that time, Dr. Style has been at King's College, London, where he now holds a readership. He has made notable contributions to physical chemistry in the fields of photochemistry and spectroscopy. During the Second World War, Dr. Style was seconded for work with the Ministry of Supply.

Metallurgy at Sheffield :

Prof. R. W. K. Honeycombe

It was recently decided that the Department of Metallurgy and the postgraduate school in physical

metallurgy in the University of Sheffield should be merged under Prof. A. G. Quarrell, who was given the title of professor of metallurgy. Dr. R. W. K. Honeycombe, senior lecturer in physical metallurgy, has now been appointed professor of physical metallurgy. An Australian by birth, Prof. Honeycombe was educated at Geelong College and the University of Melbourne. As a research student under the direction of Dr. J. Neil Greenwood, he studied the metallurgy of hard alloys of the cemented carbide type. During 1942-47 he was a research officer in the Lubricants and Bearings Section, now the Division of Tribo-Physics, of the Commonwealth Scientific and Industrial Research Organization, and did metallurgical work under the general direction of Dr. F. P. Bowden. Much of this work was aimed at the solution of Service problems arising from the War. However, some research of a more fundamental character was done in collaboration with Dr. W. Boas, including a study of the thermal fatigue of metals and alloys which show anisotropy of thermal expansion. In 1947 Dr. Honeycombe left Australia to take up an I.C.I. fellowship with Dr. E. Orowan's metal physics group in the Cavendish Laboratory, Cambridge, and two years later he was awarded the Royal Society Armourers and Brasiers' Research Fellowship. While at Cambridge, Dr. Honeycombe made a detailed study of the development of deformation bands formed during the plastic deformation of metal crystals, and afterwards, in collaboration with Dr. A. F. Brown, did electron microscope work which led to the discovery of the phenomenon of micro-slip. Since his appointment in 1951 to Sheffield, Dr. Honeycombe has had considerable teaching responsibilities in the recently established postgraduate school of physical metallurgy. He has, nevertheless, continued his research on deformation, paying particular attention to the deformation of crystals of solid-solution and age-hardening alloys. He is also studying the properties of thorium and its alloys, and the precipitation of carbides in ferritic steels.

The Coblenz Society : a New Society for Infra-Red Spectroscopy

A NEW society, the Coblenz Society, has been formed in the United States with the object of furthering work in all the aspects of infra-red spectroscopy and of providing a communication centre and forum for the thousands of scientists, research workers

and teachers in the United States who use infra-red spectroscopy. The Society has been given its name in honour of William W. Coblentz, retired chief of the Radiometry Section of the National Bureau of Standards, Washington, D.C., and pioneer in infra-red spectroscopy. It is not intended that the Society should compete with the existing formal organizations for the analytical and physical chemists, physicists, military specialists and such-like; but rather it will cut across the boundaries that separate the various disciplines so as to provide an informal mechanism by which the people who use infra-red can take joint efforts on common problems. At the Ohio State conference on molecular structure and spectroscopy, held in Columbus last June, Dr. Norman Wright, of the Dow Chemical Co., Midland, Michigan, was appointed chairman of the new Society by the executive board of the Committee on Infrared Spectroscopy. Those interested in joining the Coblentz Society should write to the registrar, Dr. V. Z. Williams, c/o The Perkin-Elmer Corporation, Norwalk, Conn.

United States Committee on Loyalty Requirements in Unclassified Research

IN connexion with the recent request by the United States Administration that the National Academy of Sciences should advise the Federal Government on its policy in dealing with relations between questions of loyalty and the awarding of Government grants and contracts in support of unclassified research, a committee has been formed with the following members: J. A. Stratton, vice-president and provost of the Massachusetts Institute of Technology (*chairman*); Robert F. Bacher, chairman of the Division of Physics, Mathematics and Astronomy, California Institute of Technology; Laird Bell, a lawyer who until recently was chairman of the Board of Trustees of the University of Chicago; Wallace O. Fenn, assistant dean of the School of Medicine and Dentistry, University of Rochester; Robert F. Loeb, director of medical service, New York Presbyterian Hospital and trustee of the Rockefeller Foundation; E. Bright Wilson, jun., Richards professor of chemistry, Harvard University; and Henry M. Wriston, president of Brown University.

Specific Gravity of Alcoholic Spirits at 20° C.

UNDER the authority of the Commissioners of Customs and Excise, tables have been prepared showing the relation between the specific gravity of spirits at 20°C. (68° F.) and the percentage of ethyl alcohol by weight and by volume, with the corresponding percentage of proof spirit (pp. 35. London: H.M.S.O., 1954; 4s. net). The tables have been compiled by Mr. A. F. Weiss, of the Government Chemist's Department, Liverpool, and are based on data from existing tables at 60° F., issued by the Commissioners in 1916, together with the values for the thermal expansion of ethyl alcohol given by the United States Bureau of Standards (*Bull.*, 9, 424; 1913). The choice of 20° C. has been made because this temperature is now commonly accepted as a standard in analytical work; it is emphasized in the preface to the tables, however, that they merely supplement and do not supersede the "Official Spirit Tables" based on 60° and 80° F. The new publication contains four tables, the first of which relates the specific gravity in air at 20° C. (relative to water at 20° C. as unity) to the percentage of proof spirit and

the percentages of alcohol by weight and by volume; the range 100-0 per cent is covered in 2,100 steps. The other three tables refer to dilutions by volume of two, three and four times, respectively; each contains three columns showing the specific gravity after dilution, the corresponding proof strength before dilution and the percentage of alcohol by volume before dilution.

Storage Equipment and Methods in Libraries

A HANDBOOK on "Modern Storage Equipment and Methods for Special Materials in Libraries" (pp. 32; 1955; 2s. 6d.) has been issued in connexion with an exhibition of such equipment and methods held in the Council Chamber of the Library Association during January 11-12. It has been prepared by R. L. Collison, from whom it is obtainable (at 7a Worsley Road, London, N.W.3), and contains a foreword by J. H. Davies. It includes notes on the handling of different types of material, including atlases, films, film strips, gramophone records, lantern slides, maps, microfilms, news clippings, newspapers and pamphlets, arranged alphabetically; there is also information useful to the research worker who has collected such materials, as well as to the librarian. Besides references under the particular headings, the handbook contains a general bibliography and a directory of advertisers and suppliers of the equipment recommended.

Paper Chromatography of Plant Viruses

RELATIVELY little has been done on paper chromatographic methods for the identification and isolation of viruses. H. W. J. Ragetti and J. P. H. Van Der Want (*Proc. Koninkl. Nederlandse Akad. Wetens.*, 57, No. 5, Ser. C. 621; 1954) have now reported in some detail on methods they have found useful for the chromatography of tomato mosaic virus on filter-paper strips with water, various concentrations of sodium chloride, acetate-acetic acid buffer solutions, and an acetone-water mixture, respectively, as solvents. Attempts to identify the presence of tomato mosaic virus with a spot that strongly absorbed ultra-violet of about 265 mμ wave-length in the chromatograms were unsuccessful. It has thus far been possible to locate the virus only by inoculating *Nicotiana glutinosa* with extracts prepared from zones cut from the paper strips. The method is considered to be promising as a simple test for the estimation of certain impurities in purified virus preparations and for the preparation of viruses for electron microscopy from low-speed centrifuged sap of diseased plants.

Diatom Flora of Sweden and Finland

THE fourth part of the extensive diatom flora "Die Diatomeen von Schweden und Finnland" (in German), by Astrid Cleve-Euler (*Kungl. Svenska Vetenskaps-akademiens Handlingar*, 5, No. 4, 1955; Stockholm. 62 Kr.), relates to the Biraphideae, that is, organisms of the affinity of species such as *Navicula*, *Pinnularia*, *Cymbella*, etc., both living and fossil species being described and illustrated, and localities enumerated. The work is essentially taxonomic in its aims and presentation, and contains no general discussion.

Guinier-type X-ray Camera

A RECENT Harwell report by R. W. M. D'Eye (A.E.R.E. C/R 1524, available from H.M.S.O., London) describes the construction of a Guinier-type

X-ray focusing camera, as developed by Prof. G. Hägg, of the University of Uppsala. This camera, which is probably the first of its kind to be built in Great Britain, has two major advantages over the Debye-Scherrer type of camera: the background is much less intense, so that the photographs are much sharper and weak lines are readily seen; and the errors in determining the Bragg angle θ are much smaller at low values of θ , the major source of error, the absorption error, being almost entirely eliminated. This is of particular importance in indexing photographs of low-symmetry structures; indeed, there are instances in which conventional cameras fail entirely, and a Guinier-type camera is indispensable. A recent example of this is a uranium oxide phase which appeared amorphous to an ordinary camera, but gave a fully indexable picture with the Guinier. The Harwell camera was constructed in the workshops of the Atomic Energy Research Establishment, at a cost of roughly £200.

Year-book of the Textile Institute for 1954-55

THE year-book of the Textile Institute for 1954-55 (pp. 248. Manchester: Textile Institute, 1955; 15s.), besides giving many of the features of the previous six issues, such as lists of members and of textile and allied organizations, Institute committees, sections and branches, etc., contains details of the changes in the Institute's design competitions which take effect this year. Information about the Institute's examinations and scholarships is also included, as well as lists of the Mather Lectures, Inaugural Lectures and Emsley Lectures, and details of the Institute's publications (including text-books). In addition, the year-book gives a list of trade and technical periodicals held by the Institute, and two useful bibliographies—one of introductory textile literature, and the other a classified list of books on textile subjects, mostly books published since 1945. There are also lists of films of textile subjects, indicating the sources from which they can be obtained, and of standard methods of testing for textiles, in which those which have been published as British Standards are distinguished.

National Science Foundation, Washington, D.C.: Fellowships for 1955-56

THE National Science Foundation, Washington, D.C., has announced the award of 715 pre-doctoral graduate fellowships and 70 post-doctoral fellowships in the natural sciences for the academic year 1955-56. Of the former, 255 fellowships have been made to first-year students, 291 to students in their intermediate years, and 169 to those in their last year. The distribution among subjects is as follows: chemistry, 167; physics, 151; engineering sciences, 107; mathematical sciences, 52; zoology, 50; biochemistry, 35; earth sciences, 30; psychology, 27; microbiology, 20; botany, 16; agriculture, 14; medical sciences, 11; genetics, 10; astronomy, 9; biophysics, 8; anthropology, 5; and general biology, 3. Of the post-doctoral awards, 26 have been made in the life sciences, 15 in chemistry, 15 in physics and astronomy, 11 in the mathematical sciences, 2 in the engineering sciences, and 1 in the earth sciences. All the awards are tenable at any accredited non-profit educational institution of higher learning in the United States or abroad. The pre-doctoral fellowships are worth 1,400 dollars for those in their first year, rising to 1,800 dollars for those in their last year of graduate study, and post-doctoral fellowships are

worth 3,400 dollars. The fellowships include additional allowances for dependants, tuition and other normal expenses.

Metropolitan-Vickers Postgraduate Engineering Bursaries

METROPOLITAN-VICKERS Electrical Co., Ltd., of Trafford Park, Manchester, has endowed four post-graduate bursaries in electrical and mechanical engineering, each worth £400 a year, in the University of Manchester; two of these bursaries will normally be tenable in the Faculty of Technology of the University at the Manchester College of Technology. The Company has also endowed three similar bursaries tenable in the Mechanical and Electrical Engineering Departments of the Imperial College of Science and Technology, London. A particular purpose of these bursaries is to encourage graduates in physics and mathematics to undertake postgraduate study or research in engineering in preparation for entry into the electrical industry.

British Society for Research on Ageing

THE following have been elected officers and members of the executive committee of the British Society for Research on Ageing: *Chairman*, Sir Charles Dodds; *Vice-Chairman*, Sir Francis Fraser; *Secretary*, Dr. G. H. Bourne (London Hospital Medical College, Turner Street, London, E.1); *Treasurer*, Prof. P. L. Krohn; *Members of Committee*, Prof. J. F. Danielli, Dr. H. B. Fell, Prof. K. J. Franklin, Prof. P. B. Medawar and Prof. R. E. Tumbidge.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: L. J. S. Littlejohn (chief soil conservation officer, Tanganyika), regional assistant director of agriculture, Tanganyika; J. T. Moon (assistant director of agriculture, Uganda), deputy director of agriculture, Uganda; M. F. H. Selby (chief agricultural officer, Nyasaland), assistant director of agriculture, Nyasaland; A. F. W. Sheffield (deputy director of agriculture, Eastern Region, Nigeria), director of agriculture, Eastern Region, Nigeria; A. J. Fyfe and F. H. Landon (senior assistant conservators of forests, Federation of Malaya), conservators of forests, Federation of Malaya; D. S. P. Noakes (conservator of forests, Federation of Malaya), deputy director of forestry, Federation of Malaya; H. W. Catling, archaeological survey officer, Cyprus; S. D. Gangolli, government chemist, Medical Department, Uganda; A. J. Nutton, chemist, Medical Department, Hong Kong; J. R. Charter, specialist (forest botanical ecologist), Federation of Nigeria; E. G. G. Dykes, assistant conservator of forests, British Honduras; Miss A. P. M. Lynam, records officer, Geological Survey Department, Uganda; D. J. Ducker, veterinary officer, Nyasaland; W. Foulston, veterinary officer, Northern Region, Nigeria; B. L. Nestel, veterinary officer, Jamaica; K. Ogonowski, veterinary research officer, Kenya; and F. G. Peers, veterinary biochemist, Federation of Nigeria.

Conference on Production and Utilization of Electromagnetically Enriched Isotopes

A CONFERENCE on the "Production and Utilization of Electromagnetically Enriched Isotopes" will be held at the Atomic Energy Research Establishment, Harwell, during September 13-16. Several leading

members of the team responsible for the work on stable isotopes at Oak Ridge are attending, while provisional acceptances have also been received from leaders of the separator groups in France, Holland and Denmark. Although a detailed programme has not yet been prepared, sessions will be included on: (1) design and operation of large mass separators; (2) ion source and collector problems especially with high beam current; (3) separation of radioactive materials; (4) chemical aspects of the production work; (5) preparation of isotopic targets; (6) developments in stable isotopes mass-analysis; (7) utilization of electromagnetically enriched isotopes. Much of the meeting will be occupied with problems of the electromagnetic separator itself; but contributions will also be welcomed on applications of stable isotopes, especially those of an unusual type. The emphasis here should be on the principles involved and not on the details of the great variety of techniques which users may employ. On the other hand, the great volume of work on the application of the isotopes of the lighter elements, particularly of hydrogen, carbon, nitrogen and oxygen, which are more economically enriched by other methods, is specifically excluded. Abstracts of papers must be submitted before April 30, and complete manuscripts before June 30. Further information can be obtained from Dr. M. L. Smith, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

South-Eastern Union of Scientific Societies : Congress in Folkestone

THE sixtieth annual congress of the South-Eastern Union of Scientific Societies will be held in Folkestone during April 14-17. The president-elect, Sir Harold Spencer Jones, has had to withdraw, and in his place the new president will be Dr. Russell J. Reynolds, consulting physician in the Departments of Radiology and Electrotherapeutics, Charing Cross Hospital, London, whose address, to be given on April 15, will be on "Cineradiography" and will be illustrated by a film. The section presidents and the subjects of their addresses will be as follows: *Archæology*, Major H. M. Rand (the Saxon shore forts of Kent); *Botany*, Dr. Francis Rose (the flora of Kent); *Geology*, Mr. C. W. Wright (unsolved problems in Cretaceous stratigraphy and palæontology); and *Zoology*, Dr. Maurice Burton (art in animals). Further information can be obtained from the honorary local secretary, T. W. Birch, 3 Shorncliffe Road, Folkestone, Kent.

Announcements

THE Museum of English Rural Life, established some four years ago in Whiteknights Park, Reading, will be formally opened by Sir Keith Murray, chairman of the University Grants Committee, on April 27. Hitherto, the Museum has been occupied with gathering and recording material; it is now to be opened to the general public (Tuesdays, Saturdays and Sundays during the summer; and Wednesdays and Saturdays during the winter).

A SUMMER laboratory course in techniques and applications of the electron microscope, on the lines of those of previous years, will be given during June 13-25 in the Laboratory of Electron Microscopy of the Department of Engineering Physics, Cornell University, under the direction of Prof. Benjamin M. Siegel. Further information can be obtained from Prof. Siegel at Rockefeller Hall, Cornell University, Ithaca, N.Y.

THE British Plastics Exhibition and Convention, will be held this year at Olympia, London, during June 1-11. The Convention will consist mainly of papers on the following subjects: polymer structure and properties; expanded plastics; thermoplastics; extrusion; works study; injection moulding; patents; foundry resins; and glass reinforced plastics. Applications for tickets to the Convention should be made to the Manager, British Plastics Exhibition, Dorset House, Stamford Street, London, S.E.1.

A SECOND international conference on the biochemical problems of lipids will be held in Ghent during July 27-30 prior to the Third International Congress of Biochemistry in Brussels. The colloquium will consist of four sections: physical and chemical properties, structures, and methods of separation; metabolism and biosynthesis, and enzyme systems; phospholipids and transport; and miscellaneous biochemical problems. Application forms and further information can be obtained from the secretarial office of the colloquium at St. Jansvest 12, Ghent.

A COURSE on the use of radioisotopes in engineering has been arranged by the British Council in conjunction with the Atomic Energy Research Establishment. The course will be held during June 12-25, the first week being spent at Harwell attending lectures and demonstrations on radioisotopes, and the second week being spent in and around London visiting firms and establishments engaged upon the manufacture of radioisotope equipment and the applications of radioisotopes to particular problems. The course will be limited to fifteen members, and the fee, including accommodation, will be £40. Applications should be made to the local British Council representative or to the Director, Courses Department, British Council, 65 Davies Street, London, W.1.

THE Development Commission is offering a few training grants to British honours graduates for training in research problems in marine or freshwater science, which is designed to fit them for employment either in the Fishery Research Service of the Ministry of Agriculture and Fisheries and the Scottish Home Department or in a marine or freshwater biological research institute. The grants are worth £250-350 a year, with allowances for university fees, etc., and are tenable initially for one year, renewable up to a maximum of three years. Application forms, to be returned by May 20, can be obtained from the Secretary, Development Commission, 6a Dean's Yard, London, S.W.1.

A list of new compounds which have been made available for purchase during the past year has been published by L. Light and Co., Ltd., Poyle Trading Estate, Colnbrook, near Slough, Bucks. The list supplements that of the 1954 catalogue and contains a wide range of uncommon reagents which will be of interest to chemists and biochemists who have hitherto had to prepare such substances for themselves. A number of naturally occurring biological substances, including several enzymes, are also listed. The following are examples of the products picked at random from the list: acetochlorocellobiose; aldolase; arginase; 8-azaguanine; 2-carboxy-pyrrole; carnosinase; chondroitin sulphate; coenzyme II; 4-5- and 5-6- diaminoauracil sulphate; 2-4-, 2-6- and 3-4- dinitrotoluene; fumaryl chloride; hemi-cellulose; various methylated hydroxyquinolines; ovomucoid; purine and pyrimidine as free bases; rhodanese; squalene; and tridecyl alcohol.

THE EARTH'S MAGNETIC FIELD AND NUMERICAL WEATHER FORECASTING

AT a meeting on "Hydrodynamical Processes in Meteorology and Geophysics", held jointly by the Royal Astronomical Society and the Royal Meteorological Society on February 25, some problems of common interest were discussed. The two principal topics were convection in the earth's liquid core and its possible relation to changes in, or even maintenance of, the earth's main magnetic field, and recent advances in dynamical meteorology which may lead to improvements in weather forecasting by numerical integration of the equations of motion. It was a welcome feature of the meeting that speakers did not confine their remarks to one topic or the other, but made it clear not only that they had an interest in both but that they were also aware of underlying similarities in the problems posed. That meteorologists, geophysicists and astronomers have such common interests was the theme of the opening remarks of Sir Graham Sutton, president of the Royal Meteorological Society. After outlining progress in dynamical meteorology and methods of numerical weather prediction, in which he takes a particularly keen interest, Sir Graham said he hoped this would be the first of a long series of joint meetings of the two Societies.

The first speaker was Dr. R. Hide, who discussed some laboratory experiments he has made on thermal convection in a rotating fluid. Secular variations of the earth's (main) magnetic field are irregular and, by astronomical standards, very rapid. Since they can be shown to result from changes within the earth, perhaps the only plausible hypothesis is that they are related to hydrodynamical processes in the earth's liquid core. Sir Edward Bullard and others have suggested that motions in the core may be convective, the result of radioactive heating. It was in the hope of discovering something about the motions which would result from heating the core (from below) that the experiments were made. As a guide to setting up suitable experiments, the orders of magnitude of term in the equations of motion were estimated, on the assumption that the motion of the foci of secular change reflects corresponding motions in the core. It was found that the dominating terms ought to involve Coriolis and magnetic forces. Thus rotation should play an important part in controlling the motion.

After outlining the results of James Thompson, Exner and Fultz, Dr. Hide indicated some of his own results. The liquid (water) is contained between two cylinders which are rotated, the outer cylinder being heated, the inner one cooled. The motion depends on the rate of rotation and the rate of heating as well as on the dimensions of the cylinders. If other factors are kept constant, the motion at low rotation-rates is such that water spirals inwards at the top, outwards at the bottom. At a critical rotation-rate the motion changes to a different pattern, with a relatively narrow jet of fast-moving fluid executing wave-like oscillations between the two cylinders. The pattern does not change very much with time apart from a slow 'precession', the direction of which is reversed if the inner cylinder is heated and the outer one cooled. With relatively high temperature differences between the cylinders an interesting, quasi-periodic variation in the pattern, known as 'vacillation', develops. With very high

temperature differences the motion becomes very unsteady or 'turbulent'. Dr. Hide noted the similarity of these patterns to those shown by large-scale motions in the atmosphere. He did not discuss the application of his results to the theory of convection in the core, and it now appears that the application may be rather less direct than was at one time supposed.

The second speaker was Mr. J. S. Sawyer, who discussed the theoretical basis of numerical weather forecasting. Numerical integration of the equations of motion of the atmosphere has only recently become a practical proposition; but Mr. Sawyer attributed this advance not so much to the advent of electronic computing machines as to the stimulus given by a sufficient network of observations of upper-air conditions. Previous theoretical work has been either qualitative or too idealized. It is still necessary to idealize in order to obtain tractable equations, equivalent to the setting up of 'models' of atmospheric motion, but the essential features must be retained. A notable advance from earlier attempts by L. F. Richardson was made by Charney, who used a 'filtering' process to eliminate rapidly moving, sound-like disturbances from his model atmosphere. By retaining only the large slow-moving disturbances associated with weather, it is possible to devise a stable computing routine which may be completed, electronically, in a reasonable time. The filtering method involves the use of the 'geostrophic approximation' for the relation between wind and pressure gradient, usually a fairly good approximation for average, large-scale motion. This approximation is used everywhere except where it would imply the direct computation of vertical motion. Large-scale ascent or descent of air is very slow and in practice 'unobservable'. It is computed indirectly from the vorticity equation, an application of Helmholtz's theorem.

The simplest model, said Mr. Sawyer, is the so-called 'barotropic' model, which is concerned only with the average horizontal motion of the atmosphere between the earth's surface and the tropopause. More realistic is the 'two-parameter' model in which the dependent variables may be taken as the stream-function of the mean motion (nearly proportional to the height of the mean pressure surface) and the mean temperature, averaged along the vertical. A justification of this choice of parameters is the observed strong correlation between temperatures at different heights. Although vertical motion is eliminated in deriving the two simultaneous equations governing the rates of change of the parameters, it can easily be computed at any stage. Integration is a 'marching process' in the time dimension with steps, to ensure computational stability, of about one hour. At each stage two two-dimensional partial differential equations have to be solved. Numerical integration using grids of some two hundred points takes, on a relatively slow electronic computer, about three hours to yield a twenty-four hour forecast. Mr. Sawyer showed the results of applying this technique in two cases of special interest, one being the occasion of the recent disastrous flooding in East Anglia and the Netherlands. He referred briefly to some problems involved in dealing with still more realistic models. One problem is how to compute changes in humidity and cloud formation, for condensation modifies the

dynamical behaviour, especially as regards detail on a slightly smaller scale than that of the patterns which the two-parameter model reproduces reasonably well. Mr. Sawyer was only able to mention some recent work of his on computing the intensity of 'fronts', which may go some way towards taking these factors into account.

To indicate that oceanographers are keenly interested in problems closely akin to the main topics, Mr. H. Charnock showed a film of experiments by von Arx with a rotating bowl of fluid. Raised boundaries on the concave inner side of the bowl represent the continental coast-lines, the fluid itself the oceans. The fluid is set in motion relative to the rotating bowl by jets of air representing the drag due to the Westerly and Trade winds. It was noticeable how faithfully the broad outline of the main ocean currents is reproduced in the model. The experiment was designed to test the well-known theory due to Stommel and Munk of the wind-driven ocean circulations.

During an interval for discussion, Mr. T. V. Davies described some theoretical work he had done relating to the experiments made by Hide. He gave a formula for the stability of the wave-like pattern occurring at relatively high rotation-rates in terms of the Richardson number and what has been called the Rossby number (the ratio of the relative motion of the fluid to the motion of the cylinders). He also gave a formula, based on earlier work by Lorentz, relating these two parameters. Unfortunately there was too little time to do justice to this interesting, important but rather complicated subject. It is to be hoped that Mr. Davies will be given an opportunity to present his work in detail and that more time will be allotted for its discussion.

The last speaker was Dr. E. T. Eady, who discussed the properties of 'turbulent' transfer in rotating convecting fluids, with applications to the theory of the general circulation of the atmosphere and to the theory of the earth's main magnetic field. His general theme was that the transfer properties of turbulence are not always of a diffusive nature, as is assumed when effective eddy-transfer coefficients are postulated, but are sometimes anti-diffusive in character to the extent that organized patterns may be built up as a result of the transfer. Moreover, the transfer properties depend on the nature of the process which maintains the turbulence against dissipative forces, and the only reliable guide is a theory of the mechanism. Dr. Eady illustrated these points by considering some aspects of the so-called 'general circulation' of the atmosphere. The large-scale 'eddies' (corresponding to depressions and anti-cyclones) are a form of convection modified by rotation to such an extent that the heat transfer associated with their continued regeneration is in a slanting direction from a heat source in low latitudes to a radiative sink at higher levels in high latitudes. As a secondary feature these eddies also 'transfer' angular momentum. The nature of this transfer, which results in the maintenance of the Westerlies and Trades against surface friction, is readily understood in terms of the average structure which theory shows these eddies ought to have (and which they are observed to have); but it cannot be understood in terms of any simple diffusion hypothesis, whether this be based on transfer of angular momentum or on transfer of vorticity.

Transferring his attention to the problem of convection in the earth's core, Dr. Eady pointed out

that, due to the varying ellipticity of the geoids and variation in surface temperature, the inner core ought, because of the resulting horizontal density gradients, to rotate more slowly than the mantle. Observed irregular variations in the length of day are consistent with irregular free convective motion in the liquid core. He then outlined a possible natural dynamo mechanism for the maintenance of a variable main magnetic field. Supposing initially a small, approximately dipole (magnetic mode) field to exist, the gradient in rotational velocity previously deduced would wind the lines of force around the earth's axis, leading to a large electric mode field (lines of force roughly parallel to lines of latitude). Convection would draw out the electric mode field into loops. Statistically these loops would tend to set themselves most frequently so that the lines of force had the same direction as the original dipole field where this is strongest, near the inner core. Finally, because of the finite electrical resistance, the lines of force in the sides of the loops near the mantle would diffuse through, ultimately into space, leading to an increase in the strength of the initial dipole which might be sufficient to maintain it against natural decay.

In the discussion, Dr. J. M. Stagg asked how the secular variations could be due to convection in the core since some of the foci of variation are close together. Prof. H. Bondi agreed, pointing out that spherical harmonics of high order decrease rapidly with radial distance. However, Dr. F. J. Lowes said that actual calculation shows that the secular variation is consistent with dipoles in the core of only moderately large strength. Prof. Bondi wondered whether all dynamo theories are invalidated by either Cowling's theorem or a theorem of Batchelor on homogeneous turbulence. Dr. Eady replied that Cowling's theorem does not apply if the field is maintained by turbulent motion; also, the theorem of Batchelor does not apply to the theory he had put forward because homogeneous turbulence has only diffusive properties whereas the mechanism he envisaged was anti-diffusive in one important respect.

E. T. EADY

BUFFALO HUNTING IN ARNHAM LAND

IT is difficult to believe that the docile, domesticated water-buffaloes of the East Indies are the same species as the fierce and dangerous buffaloes hunted in Western Arnhem Land in Australia (*Austral. Mus. Mag.*, 11, No. 8). Yet the water-buffalo forms an interesting link between Australia, Indonesia and India, and was a profitable experiment in the colonizing of northern Australia in the early nineteenth century. Three buffaloes were imported from Timor into the Melville Island settlement in 1825, and others were introduced over the next twenty years. Once ashore, they became too wild and dangerous to domesticate.

They were well established on Melville Island and on the Cobourg Peninsula on the mainland by 1849. With no natural enemies except the dingo, and as they were remarkably resistant to disease, the animals gradually spread southward into a natural and ideal environment in the vast swamps and grasslands of the Mary, Adelaide and Alligator Rivers and westward to the Darwin coast. Stray bulls have wandered into Victoria Downs, some five hundred

miles to the south, and as far east as Caledon Bay on the Gulf of Carpentaria. The increase was so rapid that by 1895 it was estimated that there were six thousand buffaloes on Melville Island and about sixty thousand on the mainland.

The water or Asiatic buffalo, *Bubalis bubalis*, is a powerful animal, more than five feet high and almost ten feet long. It is heavily built, has short powerful legs with white fetlocks and large hoofs, a short tail and brown hair on an ashy-grey to blackish hide. The immense, hollow and sharply pointed horns may be crescentic in shape or develop into several spirals. The wild herds do not roam far afield from where they were born, their spread through the country in small herds being gradual as their numbers increase. They stay near water, in which they will stand for hours side by side, with only the wide muzzles and horns of their long heads uncovered. The bulls fight for control of a herd of cows in the autumn mating season, and old bulls unable any longer to hold their own with their younger rivals become wandering outcasts of an extremely dangerous nature. A cow bears one calf each year. The bulls will charge a foe threatening the herd.

This buffalo is a native of north-eastern India, where wild ones cause considerable damage to crops. It has a reputation for being the most dangerous animal after the tiger, and is always shot by hunters from an elephant. Hunting began in Australia in 1885, but after 1905 the great and uncontrolled slaughter of the beasts soon depleted the herds perilously and the Government took steps to save them. Permits are now issued for hunters to operate in a defined area. They are allowed to shoot a quota of bulls, but no cows. In recent years between six and eight thousand buffalo skins have been marketed annually for heavy machinery belts and similar uses, at an average price of between £5 and £6 per skin.

The hunting of buffaloes in western Arnhem Land is a dangerous and strenuous job, carried out in the dry season. It demands great horsemanship, skilful shooting and endurance above the ordinary. In the past, the ruthless depletion of the herds, the employment of natives who get little reward but disrupted lives, added to its undesirable nature; these defects have now been rectified. As the dingo is the only natural enemy of the buffalo in Australia, the shooting of a specific number each year is essential or the herds would expand beyond the country's resources to sustain them.

MICROWAVE AMPLIFICATION BY STIMULATED EMISSION OF RADIATION

A NEW instrument called the 'maser' (microwave amplification by stimulated emission of radiation) has been invented by Prof. C. H. Townes, of the Physics Department, Columbia University, for which the claim is made that it enables time to be measured with an accuracy of one part in 10^{11} . The 'clock' used is an ammonia molecule which radiates an electric dipole spectrum as a set of lines of about 6 mm. wave-length and, as used in the instrument, maintains its frequency to the above order of magnitude. This would be sufficient to enable it to measure variation in the rate of rotation of the earth.

According to the details issued by Columbia University, the instrument consists of a molecular

beam of ammonia molecules which are excited in an electric field and then pass into a tuned cavity-resonator, where they induce each other to radiate by negative absorption (in effect, giving a form of chain reaction). In this way, all factors causing broadening or displacement of the line emitted are reduced to a minimum. It seems that the method of use is to extract by means of wave-guides the radiation emitted by two 'masers', tuned to different but adjacent frequencies by the ammonia spectrum. When mixed, the beat frequency can then be counted electronically. The 'maser' is also claimed by its inventor to be very effective as an amplifier. The signal is fed into the resonant cavity, and a molecular beam, too weak to cause a complete chain-reaction, is introduced. The signal controls the rate of emission of the radiation, again by negative absorption, and, it is stated, the system is almost completely free from noise. Thus it would be very useful for amplification at millimetre wave-lengths. A limitation, however, would appear to be that the device is scarcely tunable. The only frequencies available are the half-dozen or so lines of the ammonia molecule, all in the 6-mm. region of the spectrum, and the lines of other chemical compounds. It is not stated what sort of a total band may be expected ultimately to be covered by the frequencies of various compounds.

The 'maser' is not the only time-measuring device using microwave spectra of molecules. The alternative method is to use an absorption technique, tuning a conventional oscillator on to exactly the molecular frequency. But Prof. Townes claims that this method is considerably less accurate. As at present built, the 'maser' is a fairly large device, a few cubic feet in volume, but Prof. Townes suggests that this can be considerably reduced. He proposes that, apart from being used as an accurate clock for experimental work on the earth's rotation period, it might also serve as a frequency standard for radio frequencies generally. This would certainly give greater accuracy than the usual quartz crystal, but it is doubtful if this is required, and the method would be less convenient to use, except perhaps in the region of centimetre waves.

MYXOMATOSIS OF RABBITS

THE second report of the Advisory Committee on Myxomatosis* follows fairly soon after the first report (see *Nature*, 173, 856; 1954) and records that this disease, which appeared in Kent, Sussex, Essex and Suffolk in 1953, had, by the end of 1954, spread to every county in Great Britain except Selkirk. It had appeared as far north as the Orkneys, but its spread was most marked in southern England and in Wales, only isolated outbreaks occurring in northern England and Scotland. A map issued with the report shows the extent of the distribution of the disease at the end of 1954. In Europe the disease exists in France, where it has resulted in the virtual disappearance of rabbits over large areas, and in Belgium, Luxembourg and elsewhere. It also exists in Ireland.

In view of reports that symptoms resembling those of myxomatosis have been reported in animals other

* Ministry of Agriculture and Fisheries—Department of Agriculture for Scotland. Myxomatosis: Second Report of the Advisory Committee on Myxomatosis. Pp. 11+6+1 map. (London: H.M.S.O., 1955.) 1s. net.

that the rabbit (sheep, cats, dogs, hedgehogs, etc.), the Committee says that there is no evidence that the disease can infect man or any animal other than the rabbit. It causes rabbits "much discomfort and distress", but the animals continue to feed until they die, and the Committee is unable to decide whether they suffer pain. They display the symptoms for about a week. The Committee commends the efforts of those who try to kill rabbits affected. The disease is not usually spread by airborne infection, nor by contamination of herbage. It is spread by contact; and, in Great Britain, by the European rabbit flea, which may be disseminated, when it is capable of transmitting the disease, by crows, magpies, buzzards, gulls, foxes and perhaps other predators and scavengers which feed on the diseased rabbits. Mosquitoes, which are the principal vectors in Australia, have not, so far, played much part in spreading the disease in Great Britain, except in some coastal areas. It is possible that, if summer in 1955 is more favourable to mosquitoes, they may play a greater part. Rabbits develop an immunity, but this is not permanent and is not passed on to the offspring; probably less than 1 per cent of rabbits in Great Britain developed immunity in 1954. Nevertheless, the number of immune survivors may increase in the future, and these may be able to re-establish rabbit populations. It is therefore best, the Committee thinks, to kill as many rabbits as possible now, and it commends the organized efforts now in operation to this end and recommends that they should be augmented and given Government help. The Committee expects the disease to spread still more in 1955 and to kill far greater numbers of rabbits then. The critical time for the disease will probably be the winter of 1955-56, when the number of rabbits will probably be the lowest for more than a century. It may then be necessary to intensify the drive against the survivors.

The Committee recommended in its first report that no attempt should be made by man to help the spread of the disease and then decided that it should not be made a criminal offence to spread the disease; it still holds this view, but the Government, in response to opinion in Parliament, accepted an amendment to the Pests Act which made it an offence to use an infected rabbit for spreading the disease.

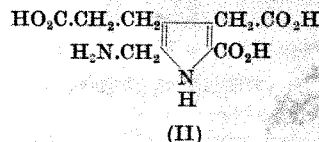
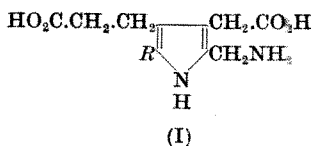
The help given to breeders of domestic rabbits has given good results. The vaccine issued has protected almost 90 per cent of rabbits, and better vaccines are being sought. The importing of rabbits not indigenous to Britain is now prohibited by law. The Food and Drugs Act protects the public against the sale of rabbit meat derived from infected rabbits. Those who are interested in the actual effects of the disease to date will be interested to learn that it has already affected the habits of foxes, which are now turning to rats, fowls and sheep for food, and no doubt the feeding habits of stoats, weasels and other predatory mammals and birds are similarly affected. There has, however, already been a marked improvement in vegetation, especially in grass, so that the loss of some £50 million caused by rabbits is being mitigated. On the other hand, the fur, fur-felt and fur-felt hat trades and the trappers of rabbits must inevitably suffer; and steep chalk downland pastures owe their existence, in some areas, to continuous grazing by rabbits, so that, unless these are now stocked by sheep and cattle, they may become agriculturally valueless.

G. LAPAGE

CHEMICAL SYNTHESIS OF PORPHOBILINOGEN.

Synthesis of Porphobilinogen and iso-Porphobilinogen Carboxylic Acids

PORPHOBILINOGEN, a substance present in the urine of sufferers from acute porphyria, was first isolated by Westall¹ and ascribed the structure (I, $R = H$) by Cookson and Rimington². In the course of an investigation of amino-acids with a pyrrole nucleus, we have synthesized carboxyporphobilinogen (I, $R = CO_2H$) and the isomeric tricarbonylic acid (II), which we propose to designate iso-porphobilinogen carboxylic acid.



2-Methyl-5-carboxypyrrole-3-acetic acid-4-propionic acid triethyl ester³ was oxidized to the 2-carbinol with lead tetracetate at 20-25° (melting point, 99°; found: C, 57.5; H, 7.2; N, 3.9. $C_{17}H_{25}O_7N$ requires C, 57.5; H, 7.1; N, 3.9 per cent), and this to the 2-aldehyde, melting point 67°, with the same reagent at 100° (found: C, 57.7; H, 6.8; N, 4.15; $C_{17}H_{23}O_7N$ requires C, 57.8; H, 6.5; N, 4.1 per cent). Dinitrophenyl hydrazone, melting point 179°; found: C, 51.6; H, 5.5; $C_{23}H_{22}O_{10}N_4$ requires C, 51.8; H, 5.1 per cent). The oxime (melting point 58°; found: C, 55.7; H, 6.8; N, 7.5; $C_{17}H_{24}O_7N_2$ requires C, 55.4; H, 6.5; N, 7.6 per cent) on reduction with sodium amalgam gave the 2-amino-ester, melting point 225°; (found: C, 57.7; H, 7.0; N, 7.7; $C_{17}H_{26}O_6N_2$ requires C, 57.6; H, 7.3; N, 7.9 per cent), which, on hydrolysis, gave the acid (I, $R = CO_2H$), isolated through its copper salt. This acid is unstable, rapidly becoming deep purple-pink, and proved extremely difficult to purify and analyse (found: C, 47.9; H, 5.5; N, 10.5; $C_{11}H_{14}O_6N_2$ requires C, 48.9; H, 5.2; N, 10.4 per cent). Since, however, it should yield a substance of the structure suggested for porphobilinogen, we attempted, although only milligram quantities were available, to eliminate the 5-carboxyl group by heating at 105° for 15 min. A mixture resulted which, on treatment with acid, behaved spectroscopically as if it contained porphobilinogen. Prof. C. Rimington has kindly examined this product for us by paper chromatography (see following communication), and shown that it undoubtedly contains traces of porphobilinogen.

This work is being continued with the object of securing enough material for complete chemical identification and biological testing; but as it constitutes a proof of the structure of porphobilinogen by synthesis, it appears to be desirable to record it at the present stage.

Ethyl 4-2'-carbethoxyethyl-3-carbethoxymethyl-5-methylpyrrole-2-carboxylate⁴ was oxidized to the 5-carbinol, melting point 102° (found: C, 57.8; H, 6.9; N, 3.9 per cent), and the aldehyde, melting point 69° (found: C, 57.5; H, 6.5; N, 4.0 per cent). Dinitrophenylhydrazone, melting point 140°; found: C, 51.75; H, 5.4 per cent), of which the oxime (melting point 88°; found: C, 55.65; H, 6.85; N, 7.7 per cent) on reduction, gave the triethyl ester of

(II), melting point 185° (found: C, 57.8; H, 7.4; N, 8.3 per cent), from which the free acid was obtained by hydrolysis (found: C, 48.4; H, 5.9; N, 10.4 per cent). This acid is not decarboxylated when heated at 105° for 15 min.

K. S. N. PRASAD
R. RAPER

King's College (University of Durham),
Newcastle upon Tyne.
March 9.

¹ Westall, R. G., *Nature*, **170**, 614 (1952).

² Cookson, G. H., and Rimington, C., *Nature*, **171**, 875 (1953); *Biochem. J.*, **57**, 476 (1954).

³ MacDonald, S. F., *J. Amer. Chem. Soc.*, **75**, 5448 (1953).

⁴ MacDonald, S. F., *J. Chem. Soc.*, 4188 (1952).

Decarboxylation of Porphobilinogen- and Iso-Porphobilinogen- α -Carboxylic Acids

PYRROLE derivatives such as the tricarboxylic acids (I) and (II) synthesized by Prasad and Raper (see preceding communication) give no immediate colour with Ehrlich's reagent (*p*-dimethylaminobenzaldehyde in c. 5 N hydrochloric acid), but do so very slowly at room temperature or rapidly on heating as the α -COOH group is displaced by the coupling reagent. Porphobilinogen, with H in place of COOH in (I), reacts at once at room temperature.

Prasad and Raper attempted the partial decarboxylation of (I) and (II), in order to form porphobilinogen and an isomeric *iso*-porphobilinogen, respectively, by heating at 105° for 15 min., and we examined their reaction products by paper chromatography, using butanol/acetic acid/water as solvent and Ehrlich's reagent as spray¹. There appeared to have been no decarboxylation of (II) and, in the case of (I), only a trace of promptly reacting material was present in the position expected for porphobilinogen. Some general decomposition had taken place, resulting in a residue of brown immobile material at the point of application. On heating the sprayed paper at 100° for about 1 min., strong red spots appeared due to unchanged (I) and (II), the *R_F*'s being less than that of porphobilinogen. Owing to the small amount available of the acids (I) and (II), we have carried out most of our further work on the materials which had been subjected to the unsuccessful attempt at decarboxylation by heating; the symbols (I) and (II) are retained.

In one experiment, lactam formation was attempted by applying the conditions used by Cookson and Rimington², namely, reaction in aqueous pyridine with acetic anhydride at 0° . Paper chromatography

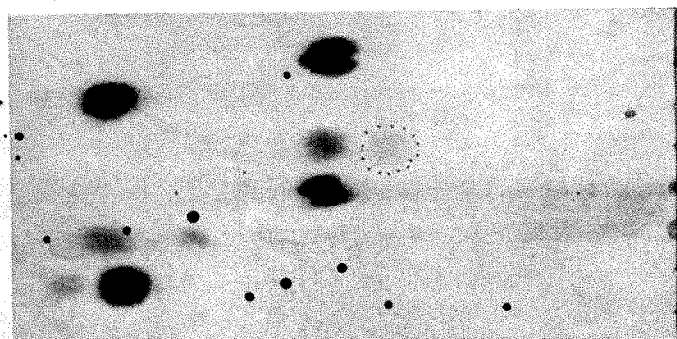
of (I) so treated showed not only a spot developing after heating in the same position as the untreated material, but also promptly appearing spots in the same positions as porphobilinogen lactam and acetyl-porphobilinogen markers, but superimposed on much general streaking. The possibility of decarboxylation in aqueous pyridine was therefore investigated, and it has been found that smooth and practically quantitative decarboxylation of (I) in the α -position can be achieved by heating in 50 per cent aqueous pyridine in the presence of a trace of copper acetate for about 2.5 min. (boiling water-bath).

A chromatogram of the reaction mixture (Fig. 1) shows the appearance of porphobilinogen and the virtual disappearance of (I). Moreover, after adding acetic anhydride to the reaction mixture, as for lactam formation, and chromatographing, the porphobilinogen spot disappears and spots appear in the same positions as porphobilinogen lactam (strong) and acetyl-porphobilinogen (very weak) markers respectively. A third, unidentified, weak spot lies between porphobilinogen and its lactam.

The behaviour of the synthetic products derived from (I) is thus chromatographically identical with that of the natural material, its lactam and acetyl derivative.

Heating (II) for 2.5 min. in 50 per cent aqueous pyridine containing a trace of copper acetate leads to complete α -decarboxylation, the resulting *iso*-porphobilinogen giving a prompt red colour with Ehrlich's reagent at room temperature and having an *R_F* the same as that of porphobilinogen itself. Further treatment of the reaction mixture with acetic anhydride, as for lactamization of porphobilinogen, affords an Ehrlich-positive product which when chromatographed reveals two components. These give prompt colour with the reagent at room temperature but fade considerably more rapidly than do the spots of porphobilinogen lactam and acetyl-porphobilinogen; moreover, their positions are different, the less mobile one lying between porphobilinogen and its lactam, the other lying very slightly in advance of the lactam. A further difference was noted under ultra-violet light; porphobilinogen lactam shows an intense blue fluorescence whereas the more mobile spot, derived from α -decarboxylated (II), shows the merest trace, if any, of fluorescence. The identity of these products remains to be determined, but it is possible that one of them is the *N*-acetyl derivative of *iso*-porphobilinogen.

After treatment of the tricarboxylic acid (II) as for lactamization, no Ehrlich-reacting material could be detected chromatographically with the usual amount of material either with or without heating of



Porphobilinogen

Porphobilinogen lactam

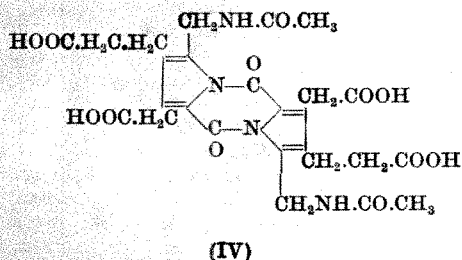
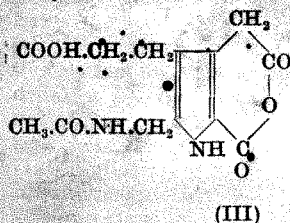
Substance I: the spot ringed by dots develops strongly on heating

Substance I + aq. pyridine + copper acetate heated 2.5 min. in water bath

As above, then lactamized by addition of acetic anhydride at 0° C.

Porphobilinogen + aq. pyridine + acetic anhydride at 0° C. Porphobilinogen lactam (strong) and acetyl-porphobilinogen (weak)

Fig. 1



the sprayed paper. From an examination of the structure of (II), the possibility emerges that the cyclic anhydride (III) may have been formed which, having no free α -position, nor any easily displaceable group in that situation, would not be expected to develop colour with the Ehrlich reagent. Alternatively, the formation of the pyrocoll (IV) (presumably N-acetylated) might be considered, although with known pyrrole α -carboxylic acids this reaction has been reported only after heating with acetic anhydride².

C. RIMINGTON
S. KROL

Nuffield Unit for the
Investigation of Pyrrole Pigment Metabolism,
Department of Chemical Pathology,
University College Hospital Medical School,
London, W.C.1.
March 9.

¹ Cookson, G. H., and Rimington, C., *Biochem. J.*, **57**, 476 (1954).

² Fischer, H., and Orth, H., "Die Chemie des Pyrrols", **1**, 236 (Akad. Verlagsgesell., Leipzig, 1934).

CONDITIONS OF EXPLOSION OF AZIDES

Effect of Size on Detonation Velocity

INITIATION and growth of explosion. Some recent experiments¹ have shown that if azide crystals of different sizes are heated at a fixed temperature, crystals greater than a critical thickness will explode, whereas those below a critical thickness will decompose slowly. The critical thickness decreases with increasing temperature, and for a temperature of c. 400° C. it is a few microns. Additional experiments¹, in which azides were irradiated with electrons, neutrons and fission products, show that the activation of a small group of adjacent molecules is not sufficient to cause explosion. These observations support the view put forward earlier² that the necessary size of hot spot is large on a molecular scale (10^{-5} – 10^{-8} cm. in diameter). Courtney-Pratt and Rogers describe below the initiation of explosion in azides by very intense ultra-violet light. These results may also be explained on a thermal mechanism involving the formation of a 'hot layer' of thickness c. 10^{-4} cm. which is in the same range.

Detonation velocity in high explosives. In all this previous work we have been concerned with the influence of size on the first stage of the explosion—the initiation and growth. We have now extended the experiments and studied the influence of physical dimensions on the last stage of the explosion, that is, on the stable detonation. The effect of charge diameter on the detonation velocity has been studied by a number of workers (for example, Bichel, Mettengang, Dautriche, Kast, Hiscock, E. Jones, Paterson and Ford) and the results have been summarized by J. Taylor³ and by Eyring *et al.*⁴. The experiments have been almost exclusively concerned with high explosives such as TNT and complex mixtures containing nitroglycerine: in all cases the charge diameters were large (of the order of 1–20 cm.) compared with the lengths of the reaction zones. The estimated length of the reaction zone of finely powdered TNT is, for example, about 0.3 cm. and that of liquid nitroglycerine is 0.04 cm. The detonation velocity increased with the diameter of the explosive charge, approaching a maximum asymptotically, and the results may be explained in terms of the hydrodynamic theory.

Detonation velocity of azides. Little work has been done with the initiating explosives, and the experiments described here deal with the effect of thickness of charge on the detonation velocity of lead azide when pressed into very thin sheets or slabs. The thickness of these was comparable with the anticipated length of the reaction zone and varied from about 20 to 500 microns. The sheets were 1.3 cm. long and 0.5 cm. wide, and were made in a device which ensured that the density did not vary by more than a few per cent from one sheet to another. The mean density of the sheets was 3.14 gm. cm.⁻³, compared with the crystal density of about 4.60 gm. cm.⁻³. 'Pure' lead azide from a single batch was used throughout. The detonation velocity was determined by means of a simple drum-camera. A sheet of known thickness was placed at the end of a trail (about 2 cm. long) of powdered lead azide on a glass plate over a slit, and the explosion initiated by means of an electrically heated wire in the powder. The results are plotted in Fig. 1. It will be seen that for sheets of thickness of 400 microns and greater, the detonation velocity is constant at c. 5.5 km./sec. For charge thicknesses less than this, the detonation velocity decreases steadily and falls to c. 2 km./sec. when the thickness is c. 20 microns.

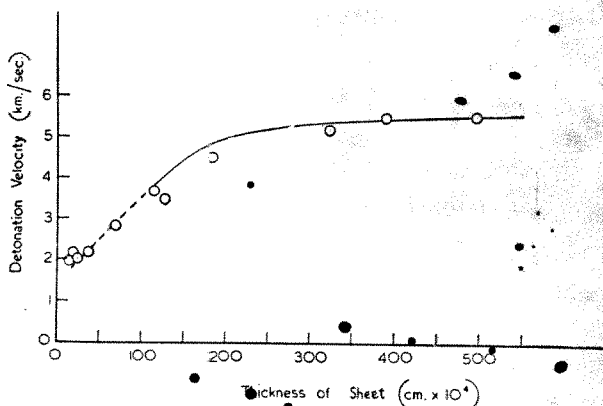


Fig. 1. Relation between detonation velocity and thickness for compressed sheets of lead azide. The experimental points lie on the continuous curve which has been calculated from the hydrodynamic theory.

An attempt has been made to explain these results in terms of the expanding jet theory of H. Jones⁵ (itself an extension of the hydrodynamic theory) modified to apply to the present experimental conditions. The theory is based upon the fact that in condensed explosives a lateral expansion of the decomposing materials will always take place. If this expansion within the reaction zone takes place before the reaction is complete, part of the decomposition occurs at a lower effective loading density, and the detonation velocity will therefore be lower than if no lateral expansion took place. Jones's calculations were made for cylindrical charges where the constraint is symmetrical about the axis of the charge. In our experiments, with very thin sheets of explosive, this was not so, since the width of the charge is much greater than the thickness. We have assumed that the expansion is symmetrical in a vertical direction about the axis of the charge, and that no lateral expansion takes place horizontally. We should then expect the detonation velocity to decrease more gradually with decreasing thickness than it would with a cylindrical charge in which expansion in two dimensions will take place. The reaction is initiated at the shock-wave front and develops over a certain distance, X , the reaction zone. The theory provides an expression for the detonation velocity V , for any thickness of charge in terms of the maximum stable velocity V_0 and the ratio of the length of the reaction zone (X) to the thickness of the charge. From the thickness for which $V = V_0$ we can calculate X . From Fig. 1 it is seen that for lead azide the critical thickness lies between 400 and 600 microns. This gives a value for X of approximately 75 microns. The theoretical relationship between the detonation velocity and the thickness of the charge is plotted as a continuous curve. It will be seen that there is fairly good agreement between experiment and theory over the range of thicknesses for which the theory is valid, that is, for thicknesses greater than the length of the reaction zone. For charge thicknesses less than 100 microns the curve (dotted) joining the experimental points is a smooth continuation of the theoretical curve.

We may conclude, therefore, that the variation of detonation velocity with thickness of charge for azides is analogous, though on a very different scale, to that observed for high explosives and can be explained reasonably well in terms of the hydrodynamic theory. The calculated length of the reaction zone for lead azide from these experiments is c. 75 microns.

We thank Prof. H. Jones, of the Imperial College of Science and Technology, for help in modifying his expanding jet theory to suit our experimental conditions, and the Ministry of Supply (Air) for a grant to the Laboratory.

F. P. BOWDEN
A. C. McLAREN

Research Laboratory for the Physics and
Chemistry of Surfaces,
Department of Physical Chemistry,
Cambridge.

¹ Bowden, F. P., and Singh, K., *Nature*, 172, 378 (1953); *Proc. Roy. Soc.*, A, 227, 22 (1954).

² Bowden, F. P., and Yoffe, A. D., "The Initiation and Growth of Explosion in Liquids and Solids" (Camb. Univ. Press, 1952).

³ Taylor, J., "Detonation in Condensed Explosives" (Clarendon Press, Oxford, 1952).

⁴ Ewing, H., Powell, R. E., Duffey, G. H., and Parlin, R. B., *Chem. Rev.*, 45, 69 (1949).

⁵ Jones, H., *Proc. Roy. Soc.*, A, 188, 415 (1947).

Initiation of Explosion by Light and by Flying Fragments

Initiation by light. Crystalline azides decompose slowly when irradiated with ultra-violet light¹, but explosion does not normally occur. If, however, the light intensity is very great, a variety of sensitive substances may be exploded².

A study of the photo-initiation of explosion in silver azide by high-intensity light flashes has been made. Small crystals of silver azide were irradiated in vacuum with ultra-violet light from a krypton-filled quartz flash-tube. The total amount of light falling on a square millimetre of crystal in the wave-length range 2000–3600 Å. was measured by a photoelectric photometer calibrated against a chemical actinometer. (Light of wave-length less than 2000 Å. is absorbed by the quartz envelope of the flash-tube, while wave-lengths greater than 3600 Å. are not absorbed by the azide crystal or by the actinometer.) The time for the flash intensity to rise to its peak and fall to one-tenth peak was constant at $61 \pm 2 \mu\text{sec}$.

Absorption measurements show that crystals 10^{-2} – 10^{-3} cm. thick used for these experiments transmit considerably less than 0.5 per cent of light at all wave-lengths less than 3500 Å. With the crystals available it was not possible accurately to measure the absorption coefficient at these wave-lengths, but at 3500 Å. it is of the order 10^8 cm^{-1} and rises very steeply as the wave-length decreases.

It has been found that a critical amount of light is required to initiate the explosion of a crystal of silver azide. This critical light absorption corresponds to a total energy input of 8×10^{-4} cal. into each millimetre squared of the crystal. To calculate this energy the spectral distribution of the light output has been assumed to be the same as that reported by Christie and Porter³ for a lamp operating under similar conditions. The critical amount of light is independent of the mass of the crystal irradiated over the range 0.2–1.5 mgm. and of the projected area of the crystal facing the lamp. If the crystals are irradiated with an ultra-violet lamp of normal intensity, they darken considerably, due to the formation of silver by their partial decomposition. With such crystals, although absorbing light at wave-lengths greater than 3600 Å., the critical amount of light, as measured by the photometer, required to initiate explosion is not appreciably affected.

The absorption of light of these wave-lengths by a crystal causes electrons to be raised to various states of excitation. Our knowledge of the behaviour in a crystal of electrons so excited indicates that their energy will be degraded very rapidly to heat, that is, excitation of vibrational and rotational degrees of freedom. A hot layer will be formed on the surface of the crystal. With a knowledge of the variation of intensity of the flash with time, the thermal conductivity, and the absorption coefficient of the azide, the size of the hot layer and the temperature distribution within it may be calculated. At present we do not have all this information. The absorption coefficient for an ionic crystal in its fundamental ultra-violet absorption band is often of the order 10^8 cm^{-1} . At some wave-lengths less than 3500 Å. the absorption coefficient of silver azide will probably reach this figure. Hence 99 per cent of all the incident radiation between 2000 and 3600 Å. which enters the azide crystal will be absorbed in a layer the thickness

of which may vary between 4×10^{-3} and 4×10^{-5} cm., depending on wave-length.

Because of the uncertainty in the absorption coefficient, no detailed calculation of the thickness and temperature of the hot layer formed is possible. The specific heat⁴ and density⁵ of silver azide are 0.12 cal./gm. and 4.8 gm./cm.³, respectively. Therefore, 8×10^{-4} cal./mm.² would raise the temperature of a surface layer 3×10^{-4} cm. thick about 500 deg. C., assuming that the layer were heated uniformly throughout its thickness. Bowden *et al.*⁶ have shown experimentally, and Rideal and Robertson⁷ theoretically, that a hot spot with dimensions of the same order as the thickness of this layer and at a temperature of 500° C. will initiate explosion. These experiments strengthen the view that the initiation of explosion requires the formation of a hot spot which is large on a molecular scale. Further, the independence of the critical amount of light on the projected area of the crystal facing the flash-tube suggests that the smallest dimension and temperature of the hot spot are the critical parameters deciding successful initiation. The mechanism for initiation of explosion of silver azide by light appears to be essentially a thermal one. Further experiments have now been devised whereby the moment of explosion can be related to the intensity-time curve for the light-flash. The first results obtained suggest that factors other than the total energy absorbed are also important in the initiation process.

Light emission and the propagation of explosion. Absorption of light of wave-length less than 3600 Å. will cause the explosive decomposition of silver azide if the intensity is sufficiently high. Audubert *et al.*⁸ studied the light emitted when solid lead, silver, potassium and sodium azides decomposed slowly, and found that light of wave-lengths between 2000 and 2800 Å. was emitted. The spectral distribution of this light was independent of the cation, but the intensity was proportional to the rate of decomposition of the azide. If the intensity continued to increase with increasing rate of decomposition, the explosive reaction would be accompanied by high-intensity light emission. If this were so, light might play a significant part in the propagation of explosion from one sample of azide to another. An experiment has been made to test this possibility. Most of the experiments were carried out in vacuum, so that any light emitted at wave-lengths less than 2000 Å. would be utilized.

The experiment consisted of firing a sample of azide located at one focus of a front-aluminized elliptical mirror with another sample of azide located at the conjugate focus. Experiments carried out in air showed that the shock wave produced by the explosion of the first sample and focused by the mirror on the second never caused the explosion of the latter. When the experiment was carried out in vacuum with lead azide at the first focus and silver azide at the second, the silver azide exploded. Amounts of lead azide greater than a critical amount had to be fired at the first focus. Similar results were obtained using silver azide at both foci. Further experiments showed that a considerable amount of material reached the second sample of azide, although there was no direct path between the two samples. The explosion of the azide at the first focus deposited a considerable amount of lead on the mirror surface, but the optical condition of the mirror surface did not affect the result. If a fluorite window, which transmits light down to 1800 Å., was placed over the

azide at the second focus, explosion was never transmitted but the window was covered with material particles.

Flying particles and the propagation of explosion. These results show that in these experiments the transmission of detonation was by particles thrown off from the explosion of the azide at the first focus. The break-up of azide crystals and the production of flying particles as a result of thermal decomposition has been observed by Bowden and Singh⁹. There was no evidence here that ultra-violet light plays any significant part in the transmission of explosion. The nature of the particles which reached the second sample was investigated by placing a microscope cover-slip at the second focus. Microscopical examination showed that, in addition to very small particles, some large particles of the order of c. 10^{-4} cm. diameter had reached the second focus.

Particles could reach the target azide only after reflexion at the mirror surface. Hot lead particles would lose most of their kinetic energy and be cooled considerably in such a reflexion. It is unlikely that, if the larger particles were metallic lead, they would arrive at the target with sufficient energy to create a hot spot of the size required to initiate explosion. It is suggested that the larger particles arrive at the target as small fragments of undecomposed lead azide. Energy is then available to the target from their kinetic energy and from the exothermic decomposition of the particle. Further, this energy will be concentrated on an area c. 10^{-4} cm. diameter. The decomposition of such a particle could easily produce a hot spot of the size and temperature which has been found necessary to initiate the explosion of silver and other azides.

Summarizing these results, we see that the explosion of silver azide may be initiated by light provided the intensity exceeds a critical value. The mechanism is probably a thermal one, and in this respect is similar to that discussed by Bowden and McLaren in that it requires a hot layer the thickness of which is large on a molecular scale. The light emitted by the exploding azide itself does not, under the conditions of these experiments, initiate the explosion of another sample, but tiny fragments flying from the crystal readily transmit the explosion.

We thank the Ministry of Supply (Air) for a grant for apparatus and the Ramsay Memorial Fellowships Trust for a fellowship to one of us (G. T. R.).

J. S. COURTNEY-PRAATT
G. T. ROGERS

Research Laboratory for the Physics and
Chemistry of Surfaces,
Department of Physical Chemistry,
Cambridge.

¹ Garner, W. E., and Maggs, J., *Proc. Roy. Soc., A*, **172**, 299 (1939).
Thomas, J. G. N., and Tompkins, F. C., *Proc. Roy. Soc., A*, **208**, 550 (1951). Jacobs, P. W. M., and Tompkins, F. C., *Proc. Roy. Soc., A*, **215**, 254 (1952).

² Berchtold, J., and Eggert, J., *Naturwiss.*, **40**, 55 (1953). Meerkamper, B., *Z. Electrochem.*, **58**, 387 (1954).

³ Christie, M. L., and Porter, G., *Proc. Roy. Soc., A*, **212**, 390 (1952).

⁴ Yull, A. M., Ph.D. dissertation (Camb. Univ., 1953).

⁵ Hughes, E. W., thesis (Cornell Univ., 1935).

⁶ Bowden, F. P., Birch, F., Mulcahy, M. R. F., Vines, R. G., and Yoffe, A. D., *Bull. Cam. Sci. Indust. Res. Aust.*, No. 173 (1943).
Bowden, F. P., and Yoffe, A. D., "The Initiation and Growth of Explosion in Liquids and Solids" (Camb. Univ. Press, 1952).

⁷ Rideal, E. K., and Robertson, A. J. B., *Proc. Roy. Soc., A*, **195**, 135 (1948).

⁸ Audubert, R., *J. Chem. Phys.*, **32**, 405 (1937). Audubert, R., and Racq, C., *C.R. Acad. Sci., Paris*, **210**, 217 (1940). Verdier, T. E., *C.R. Acad. Sci., Paris*, **222**, 731 (1946).

⁹ Bowden, F. P., and Singh, K., *Nature*, **172**, 378 (1953); *Proc. Roy. Soc., A*, **227**, 22 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Anthocyanins of the Leaf of the Copper Beech (*Fagus sylvatica*) and the Fruit of the Cultivated Strawberry (*Fragaria virginiana*)

THE pigment of the copper beech was identified in 1932¹ as cyanidin 3-galactoside; two years later, the colouring matter of wild strawberries was stated to be pelargonidin 3-galactoside².

In the former case a small specimen of the anthocyanin was isolated in substance; but in the latter case, the conclusion was reached from the results of reactions in solution. In these tests the distinction between isomeric glycosides was made only by observation of distribution between partly miscible solvents, and this is a property known to be affected by the presence of other substances. It therefore seemed desirable to examine the chromatographic behaviour of these anthocyanins. Using synthetic specimens³ and the method of Bate-Smith and Westall⁴ (paper chromatograms; *n*-butanol-acetic acid-water, 4:1:5, as solvent; original solution in 1 per cent hydrochloric acid, 0.1 per cent with respect to anthocyanin), it was found that chrysanthemin (cyanidin 3-glucoside) and idaein (cyanidin 3-galactoside), though very similar in behaviour, could be definitely distinguished, or even separated, in a run of 24-30 hr. The R_F 's are 0.395 and 0.38 for the glucoside and galactoside respectively, but careful standardization of the conditions ensured unambiguous results. A mixture gave an elongated band, and there was no evidence of any holding back of the faster-moving glucoside by the galactoside.

The copper beech pigment (25 mgm.) was isolated as already described from leaves (1 kgm.) collected in June 1954 from a tree near the laboratory, except that the purification through the picrate was omitted. On chromatography the pigment ran like idaein and similarly, as a compact spot, when mixed with idaein. When mixed with chrysanthemin, the elongation of the coloured region was the same as that obtained with a mixture of synthetic idaein and chrysanthemin. The identification of this anthocyanin as idaein was therefore confirmed.

Sondheimer and Kertesz⁵ purified the anthocyanin of a variety of strawberry grown in the United States and found it to be callistephin, since cyanidin and glucose (as *D*-glucosazone) were obtained on hydrolysis. Although the wild strawberry (*Fragaria vesca*) was not available in sufficient quantity, we thought it of interest to examine garden strawberries (from Norfolk) with the aid of the chromatographic procedure.

Preliminary experiments showed that the divergence between pelargonidin glucoside (callistephin) and pelargonidin galactoside (called fragarin, possibly erroneously) was greater than that between the corresponding cyanidin derivatives. The R_F of the glucoside was about 0.45 and that of the galactoside, 0.38. The pigment (c. 35 mgm.) from the cultivated strawberries (1.5 kgm.) was isolated by means of a method closely similar to that used for the beech leaves. Its chromatographic behaviour was the same as that of synthetic callistephin and differed from that of synthetic pelargonidin 3-galactoside.

The possibility remains that the anthocyanin of wild strawberries may differ from that of the cultivated kinds; a precedent is the occurrence of cyanidin galactoside in European cranberries⁶, whereas those obtained from Newfoundland were found to be coloured by peonidin glucoside⁷.

R. ROBINSON
HERCHEL SMITH

Dyson Perrins Laboratory,
University, Oxford.
Feb. 21.

¹ Robinson and Robinson, *Biochem. J.*, **26**, 1650 (1932).

² Robinson, *Ber. dtsch. chem. Ges.*, **67**, 98 (1934).

³ Robertson and Robinson, *J. Chem. Soc.*, 1460 (1928). Murakami, Robertson and Robinson, *ibid.*, 2665 (1931). Grove and Robinson, *ibid.*, 2722 (1931). Nair and Robinson, *ibid.*, 1611 (1934).

⁴ Bate-Smith and Westall, *Biochim. Biophys. Acta*, **4**, 427 (1950).

⁵ Sondheimer and Kertesz, *J. Amer. Chem. Soc.*, **70**, 3476 (1948).

⁶ Willstätter and Mallison, *Liebigs Ann.*, **408**, 15 (1915).

⁷ Grove and Robinson, *Biochem. J.*, **25**, 1706 (1931). Levy and Robinson, *J. Chem. Soc.*, 2715 (1931). Grove and Robinson, *ibid.*, 2722 (1931).

Release of Aromatic Compounds from Birch and Spruce Sawdusts during Decomposition by White-rot Fungi

DURING investigations into the decomposition of lignin by soil micro-fungi, it was found that a large number of these were able to decompose several aromatic compounds which are believed to be related to lignin¹. In an attempt to discover whether such compounds are released on biological decomposition of lignin, two wood-rotting fungi, *Polystictus versicolor* and *Trametes pini*, both white-rots, were grown on birch and spruce sawdusts. 25 gm. of sawdust (previously extracted with alcohol-benzene) was added to each flask and moistened with 40 ml. of a mineral salts medium (0.1 gm. potassium dihydrogen phosphate, 0.05 gm. potassium chloride, 0.05 gm. magnesium sulphate, 0.5 gm. peptone, 1 gm. glucose, 100 ml. water). The flasks were sterilized by steaming for one hour on three successive days. The fungi produced much growth which penetrated the sawdust, causing it to become lighter in colour. After six months incubation at 22° C., 9 gm. of this material was extracted with 2 per cent sodium hydroxide. On acidification of the extract a considerable precipitate was formed which was centrifuged off; the supernatant was then extracted with ether. The ether was evaporated off and the residue dissolved in a small volume of absolute alcohol for application to chromatography papers. These were developed with a single-phase mixture consisting of *n*-propanol-ammonia (sp. gr. 0.880)-water (80:5:15), run for two periods of 24 hr. at 21° C. and dried between successive runs. Two sprays were used: (a) diazotized sulphanilic acid² for phenolic groups, and (b) 2:4-dinitrophenylhydrazine³ for aldehydes.



Fig. 1. A, vanillic acid; B, syringic acid

Fig. 1 shows the result when birch extracts were sprayed with diazotized sulphanilic acid. With this spray, vanillic acid gives an orange spot and syringic acid a red spot. Both extracts showed strong spots of each of these acids, whereas the control (which had not been inoculated) gave only very faint spots. Vanillic acid alone was released from spruce sawdust by both fungi. Using 2:4-dinitrophenylhydrazine, both fungi gave faint spots of vanillin and syringaldehyde from birch sawdust and of vanillin from spruce sawdust; but similar spots were given by the controls.

These results are of interest as they conform with chemical analyses of lignin⁴, which show the occurrence of guaiacyl and syringyl groups in hardwood lignin and of guaiacyl groups alone in softwood lignin.

These compounds are released probably by the action of extracellular enzymes produced by the wood-rotting fungi. It is possible that such molecules can thus be rendered available to micro-fungi under natural conditions, as it has been shown that such fungi do not themselves release these substances from sawdust.

M. E. K. HENDERSON

Macaulay Institute for Soil Research,
Craigiebuckler, Aberdeen.

Dec. 7.

¹ Henderson, M. E. K., and Farmer, V. C., [*J. Gen. Microbiol.*, **12**, 37 (1955)].

² Bray, H. G., Thorpe, W. V., and White, K., [*Biochem. J.*, **46**, 271 (1950)].

³ Bland, D. E., [*Nature*, **164**, 1093 (1949)].

⁴ Bräuns, F. E., "The Chemistry of Lignin" (1952).

Synthesis of Oligosaccharides by Growing Cultures of *Betacoccus arabinosaceus*

KOEPSSELL *et al.*¹ have shown recently that oligosaccharides are formed when the dextranucrase of *Leuconostoc mesenteroides* (NRRL B-512) acts on sucrose in the presence of certain simple sugars, which serve as chain-initiators. We have observed a similar phenomenon with the dextranucrase and with growing cultures of *Betacoccus arabinosaceus* (Birmingham strain). When grown on a medium containing sucrose (10 per cent), yeast extract and inorganic salts, this organism produces a dextran in which the principal glucosidic linkages are α -1:6 and the branch points involve positions 1 and 3². Fructose, traces of glucose and a ketose-containing disaccharide can be detected in the medium. The degree of branching in the polysaccharide is dependent, *inter alia*, on the magnesium content of the medium; dextran samples produced from magnesium-rich and magnesium-deficient media have been proved to have average chain-lengths of 6-7 and 40-50 anhydroglucose units, respectively³.

It has now been shown that very profound reductions in the molecular size of the dextran produced by the growing organism can be effected by the addition of suitable simple sugars to the culture medium; in extreme cases, di-, tri- and tetrasaccharides are the principal products. This work was a logical development of studies in which glucose, maltose, isomaltose and other sugars were found to serve as chain-initiators in transglucosylations by the enzyme *Betacoccus arabinosaceus* dextranucrase (cf. Koepsell *et al.*¹).

The addition of glucose (40 per cent w/v) to the standard culture medium almost completely inhibited growth of the organism, whereas with 10 per cent glucose there was good growth, accompanied by the formation of polymeric material. However, with 20 per cent glucose dextran production was noticeably depressed and isomaltose, isomaltotriose and their higher homologues were prominent on paper chromatograms of the culture solution.

The addition of 10-50 per cent maltose (w/v) to the standard medium (40 c.c., to which another 4 gm. of sucrose was afterwards added) had a similar effect; at the latter concentration the amount of product which was insoluble in 66 per cent ethanol was negligible. Paper chromatographic analysis of the solution revealed the presence of a large amount of panose, together with unchanged maltose, higher aldosesaccharides, fructose, a ketose-containing disaccharide and a ketose-containing trisaccharide. Fractionation of the mixture on a charcoal column⁴ gave a trisaccharide fraction (3.5 gm.) and a mixed oligosaccharide fraction (4.5 gm., eluted by 15-20 per cent ethanol); crystallization of the former from aqueous methanol afforded panose, melting point and mixed melting point 222-224° (decomp.) [α]_D²⁵ + 153.9° (equil.; in water).

Chromatographic evidence was also obtained of: (a) non-reducing products (presumably methyl glycosides) in the oligosaccharide range when methyl α -D-glucopyranoside (25 per cent) was added to the standard medium; (b) an unidentified trisaccharide on the addition of cellobiose (30 per cent); (c) a ketose-containing disaccharide on the addition of fructose (25 per cent); and (d) probable tri- and tetra-saccharides when lactose (10 per cent) was incorporated in a modified medium containing only 2 per cent sucrose.

These results with growing cultures, like those obtained with dextranucrase itself, point to a multi-chain mechanism of synthesis and throw light on the structural requirements for chain-initiation. In addition, they provide a convenient route for the preparation of appreciable quantities of higher saccharides (and their glycosides) with a predetermined range of molecular weight, which might well prove to be useful commercially for the production of gums, anti-staling agents for bread, plasticizers, etc. We have shown also that they simplify the difficult preparation of dextran-free dextranucrase by providing a source in which the enzyme is accompanied by only traces of the polysaccharide.

One of us (R. W. B.) thanks the Colonial Products Research Council for the award of a scholarship.

R. W. BAILEY
S. A. BARKER
E. J. BOURNE
M. STACEY

Chemistry Department,
University,
Birmingham 15.
Feb. 8.

¹ Koepsell, H. J., Tsuchiya, H. M., Hellmann, N. N., Kazenko, A., Hoffmann, C. A., Shappe, E. S., and Jackson, R. W., [*J. Biol. Chem.*, **200**, 793 (1953)].

² Stacey, M., and Swift, G., [*J. Chem. Soc.*, 1555 (1948)]. Barker, S. A., Bourne, E. J., Bräuns, F. E., Neely, W. B., and Stacey, M., [*J. Chem. Soc.*, 2395 (1954)].

³ Barker, S. A., Bourne, E. J., James, A. E., Neely, W. B., and Stacey, M., [*J. Chem. Soc.*, (in the press)].

⁴ Whistler, R. L., and Dunwo, D. F., [*J. Amer. Chem. Soc.*, **72**, 977 (1950)].

Utilization of Metaphosphate for Phosphorylation by Cell-free Extracts of *Mycobacterium smegmatis*

In a recent communication in *Nature*¹, we pointed out that it has been suggested by several authors that metaphosphate may be a source of 'high-energy' phosphate in the cells of a number of lower organisms, but that this had not been proved². The question has since been investigated in this laboratory.

Table 1. UTILIZATION OF LABILE PHOSPHATE BY CELL-FREE EXTRACTS OF *M. smegmatis*

Mixtures incubated	7-min. labile phosphate			Stable phosphate			Orthophosphate		
	Start	Finish	Change	Start	Finish	Change	Start	Finish	Change
(1) Extract + glycerol + metaphosphate	101.6	37.8	-13.8	64.1	66.8	+2.7	59.5	70.8	+11.3
(2) Extract + glycerol + adenosine triphosphate	112.2	15.8	-96.4	115.6	193.1	+77.5	66.8	86.6	+19.8
(3) Extract + glycerol + adenosine triphosphate + metaphosphate	195.6	59.8	-135.8	123.0	230.4	+107.4	69.1	99.4	+30.3

All figures represent μ gm. phosphorus per ml. of mixture

The experimental method was based on that used by Hunter³ in showing the phosphorylation of glycerol by cell-free extracts of mycobacteria. Four-day old surface growth of *M. smegmatis* was harvested, washed, and about 5 gm. (wet-weight) ground by hand with about 10 gm. acid-washed Merck alumina. It was then made into a slurry with 25 ml. of *M*/10 phosphate buffer, pH 7.40, and ground in a ball-mill for 10 min. Whole cells and alumina were removed by centrifuging three times at 2,700 *g*, each time for 10 min. All these operations were performed at as low a temperature as possible. The pH was re-adjusted to 7.40. The extract was dialysed against three changes of tap water at about 4° C. After dialysis the pH was readjusted to 7.40.

The other solutions used in the experiment were: (i) 2 per cent glycerol; (ii) 1.5 per cent solution of the barium salt of adenosine triphosphate (Schwartz Laboratories) dissolved in *N*/20 hydrochloric acid, the barium precipitated by adding potassium sulphate, the solution brought to pH 7.40, and centrifuged; (iii) 2 per cent sodium metaphosphate (Hopkin and Williams) was suspended in 1 per cent potassium sulphate, the pH adjusted to 7.40, the suspension kept overnight, its pH readjusted, the suspension centrifuged, and the supernatant diluted 1:1 with water.

5 ml. of the cell-free extract and 1 ml. each of the required solutions were pipetted into 25-ml. conical flasks; water was added where necessary to give a final volume of 9 ml., and the flasks then thoroughly evacuated and incubated at 37° C. for 4 hr. Two samples, taken at both the beginning and end of this period, were pipetted into an equal volume of ice-cold 10 per cent trichloroacetic acid and stirred. One sample was centrifuged and orthophosphate determined on the supernatant. The other was heated at 90° C. for 15 min. to extract the phosphorus compounds, centrifuged, and the total phosphorus and 7-min. labile phosphate in the supernatant determined. The results of one such experiment are shown in Table 1.

Under the conditions of these experiments, therefore, metaphosphate was hydrolysed to a slight extent to orthophosphate by the dialysed extract. In the absence of adenosine triphosphate, no further change took place. When adenosine triphosphate was added as the sole 'high-energy' phosphate source, more than 50 per cent of its labile phosphate was

converted to glycerophosphoric acid. On the addition of metaphosphate in addition to adenosine triphosphate, a considerably greater conversion of labile phosphate to glycerophosphoric was found. These results show that the cell-free extract was capable of utilizing metaphosphate for the phosphorylation of glycerol in the presence of adenosine triphosphate, presumably by phosphorylation of adenosine diphosphate to adenosine triphosphate. As the experiments were done under anaerobic conditions, metaphosphate

must have provided the energy for the phosphorylation.

As would be expected, adenosine diphosphate was capable of replacing adenosine triphosphate in the system, but adenosine monophosphate was not.

The enzyme system is being further investigated and detailed findings will be published elsewhere.

We wish to thank Dr. V. C. Barry for encouragement and critical discussion, and Arthur Guinness, Son and Co. (Dublin), Ltd., for financial assistance.

FRANK WINDER
JOAN M. DENNENY

Laboratories of the Medical Research Council
of Ireland,
Trinity College, Dublin. Dec. 3.

¹ Winder, Frank, and Denny, Joan M., *Nature*, 174, 353 (1954).

² Added in proof.—See, however, Hoffmann-Ostenhof et al., *Biochim. et Biophys. Acta*, 14, 285 (1954).

³ Hunter, G. J. E., *Biochem. J.*, 55, 320 (1953).

Tumour-initiating Action of Urethane and its Inhibition by Purine Precursors

URETHANE injected, given by mouth, or applied to the skin, induces the formation of multiple lung adenomata in mice and rats. It also inhibits the growth of some transplanted animal tumours, and induces remissions in human leukaemia. Its many other biological effects include the induction of chromosome abnormalities and mutations.

It was shown recently¹ that urethane has the power of initiating the carcinogenic change in mouse skin without being itself carcinogenic for this tissue, or producing any other detectable change in it. This was demonstrated by a technique based on that used by Berenblum and Shubik² and by others for the investigation of the stages of chemical carcinogenesis. Urethane was applied to the skin of the back and followed, after an interval, by weekly applications of croton oil. Many papillomata and some carcinomata developed. No skin tumours appeared on mice treated repeatedly with urethane alone, and only a very few on control mice treated with croton oil alone.

Little is known of the chemical processes underlying the various biological effects of urethane. Todd (quoted by Haddow and Sexton³) suggested that urethane may interfere with nucleotide synthesis.

Table 1

Group (20-30 mice per group)	Additions to drinking water	Applications to skin		Results
	1st to 11th days (inclusive)	On 4th and 7th days	22nd day onwards	Average number of papillomata per surviving mouse at the end of treatment
1	Sodium formate	(a) ethyl formate } at intervals (b) urethane } of 30 min. (c) ethyl formate }	18 weekly applications of croton oil	2.8
2	Glycine	(a) glycine ethyl ester } at inter- (b) urethane } vals of (c) glycine ethyl ester } 30 min.	18 weekly applications of croton oil	2.5
3	Sodium formate and glycine	(a) glycine ethyl ester } at inter- (b) ethyl formate } vals of (c) urethane } 30 min. (d) glycine ethyl ester } (e) ethyl formate }	18 weekly applications of croton oil	0.3
4	Nil	Urethane only	18 weekly applications of croton oil	2.3
5	Nil	Nil	18 weekly applications of croton oil	0.2

Boyland⁴ points out that urethane may prevent the methylation of uracil to thymine, and so lead to a deficiency of this purine. In support of this hypothesis he quotes McKinney, who showed that urethane can inhibit the transmethylation of nicotinamide by methionine in tissue homogenates. However, McKinney also claimed that a similar effect was produced by certain homologous carbamates, which are known to show little or no antileukæmic activity, lung tumour-inducing activity, or ability to initiate skin-tumour formation.

Boyland⁴ also refers to work by himself and Koller showing that the chromosome-damaging action of urethane can be partially neutralized by simultaneous administration of thymine, an essential constituent of deoxyribonucleic acid.

The suggestion that urethane may act in leukaemia by interference with purine synthesis was put forward by Haddow and Sexton⁵, in view of the aberration of purine metabolism in this disease.

The hypothesis which underlies the experiment, of which a preliminary report is given below, is that urethane competes with one or more of the precursors in purine synthesis, and, in doing so, perhaps takes part in the formation of an unphysiological purine-like substance. Such a substance might be responsible for some of the biological actions which have hitherto been attributed to urethane itself; for example, its antileukæmic and tumour-inhibitory effects, acting similarly to the synthetic purine antagonists such as 2,6-diaminopurine or 8-azaguanine.

It was thought that if suitable purine precursors were supplied in high concentration at the time that urethane was being administered, the tumour-initiating action of the latter for mouse skin might be inhibited. Glycine and formate were chosen for this purpose, as it was known from the work of Buchanan *et al.*⁶ that formate and glycine both supply components for the synthesis of the uric acid skeleton. Moreover, Totter *et al.*⁷ had shown that the same substances serve as precursors for the nucleic acid purines.

Since absorption of urethane through the skin is very rapid, and since 90 per cent of injected urethane is broken down (to ethyl alcohol, ammonia, carbon dioxide and water) within 24 hr.⁷, there is little doubt that the method of administration of glycine and formate adopted (see Table 1) maintained an excess of these substances throughout the period of effective presence of urethane in the body.

Five groups, each of twenty to thirty male mice of a stock albino strain, were treated as shown in Table 1.

The last column of Table 1 shows that the result of this experiment was quite definite. Large numbers of tumours appeared in group 4, and very few in group 5, as was expected from past experience. Tumour incidence in groups 1 and 2 was not significantly different from that in group 4. In group 3, however, very few tumours appeared, the incidence being not significantly higher than that in group 5.

Thus it was shown that formate and glycine administered together, in the manner described, inhibit the initiation by urethane of skin-tumour formation in the mouse, but that neither has any effect on it when administered alone.

The experiment is being repeated and extended.

I thank Dr. M. E. Salaman for valuable advice, and Drs. G. H. Beaven and E. A. Johnson for constructive criticism during the preparation of this communication. The expenses of this research were partly defrayed out of a block grant from the British Empire Cancer Campaign.

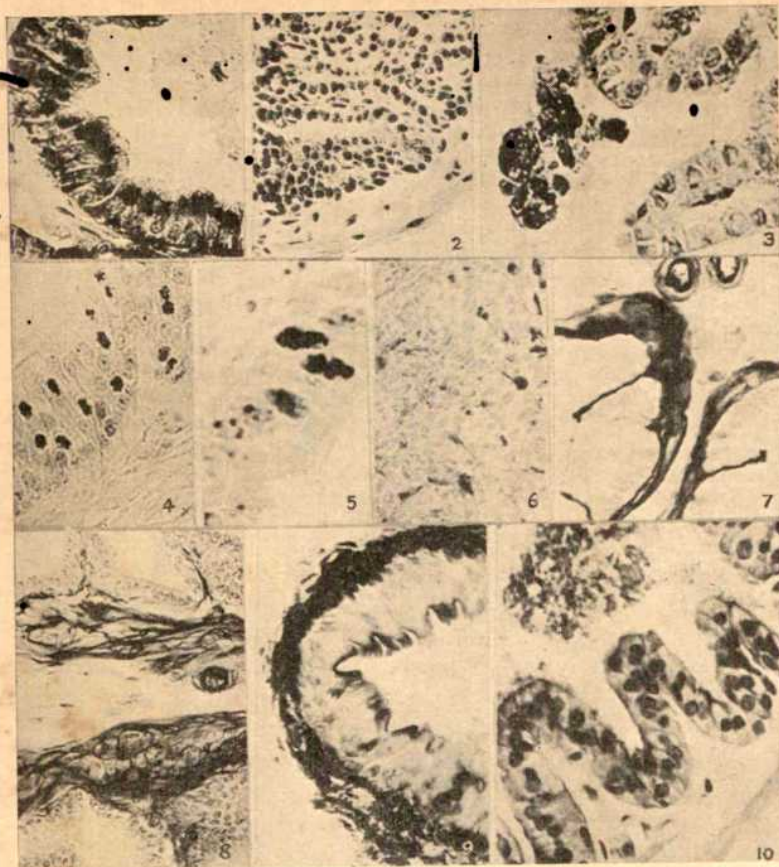
F. J. C. ROE

Cancer Research Department,
London Hospital Medical College,
London, E.1.
Feb. 9.

- ¹ Salaman, M. H., and Roe, F. J. C., *Brit. J. Cancer*, **7**, 472 (1953).
- ² Berenblum, I., and Shubik, P., *Brit. J. Cancer*, **1**, 379 (1947).
- ³ Haddow, A., and Sexton, W. A., *Nature*, **157**, 500 (1946).
- ⁴ Boyland, E., *Cancer Res.*, **12**, 77 (1952).
- ⁵ Buchanan, J. M., Sonne, J. C., and Delluva, A. M., *J. Biol. Chem.*, **173**, 81 (1948).
- ⁶ Totter, J. R., Volkin, E., and Carter, C. E., *J. Amer. Chem. Soc.*, **73**, 1521 (1951).
- ⁷ Skipper, H. E., Bennett, L. L., Bryan, C. E., White, L., Newton, M. A., and Simpson, L., *Cancer Res.*, **11**, 46 (1951).

Histochemical Control in Biochemical Estimation of Prostatic Phosphatase Activity

BIOCHEMICAL estimation of acid or alkaline phosphatase activity of the prostate sometimes indicates no change under experimental conditions, or in some cases an increase or decrease. Histochemical examination of the gland under such conditions can show fundamental alterations in distribution of phosphatase activity that are not reflected



- (1) Localization of acid phosphatase activity in Golgi region of the epithelial cells in normal mouse prostate.
- (2) Localization of acid phosphatase activity in nuclei of epithelial cells in mouse prostate after castration and implantation of stilboestrol.
- (3) Acid phosphatase in positive necrotic material and in nuclear membranes in mouse prostate autografts.
- (4) and (5) Localization of acid phosphatase activity in dividing nuclei and nucleoli of resting cells in mouse prostatic autografts treated with methyl cholanthrene.
- (6) Localization of acid phosphatase in stromal phagocytes in methyloholanthrene-induced carcinoma of mouse prostate autografts in which glandular character has been lost.
- (7) Alkaline phosphatase activity in basement membrane and stroma underlying acini in normal mouse prostate.
- (8) Partial loss of alkaline phosphatase activity from normal site, and increase in connective tissue associated with the sheaths of hyperplastic smooth muscle of stroma in mouse prostate after castration or stilboestrol implantation.
- (9) Alkaline phosphatase activity in basement membrane, stroma and apices of cells and less intense in the nuclei of autograft of mouse prostate of three weeks.
- (10) Localization of alkaline phosphatase activity in nuclei of epithelial cells in autograft of mouse prostate of two months.

in the biochemical estimations, which can therefore give rise to most misleading conclusions. Some examples will illustrate this.

(1) Acid phosphatase. In Fig. 1 (mouse prostate), acid phosphatase can be seen localized mainly in the Golgi region of the epithelial cells. After castration (Fig. 2) the enzyme has become localized almost exclusively in the nuclei, the Golgi region having become negative. Similar results can be obtained by the implantation of stilboestrol, and they can be reversed to normal by removal of the stilboestrol or implantation of testosterone into the castrated animal. These changes, which must be of fundamental significance in the functioning of the prostate, would not be reflected at all in quantitative estimations of the acid phosphatase content of the prostate. A point of fundamental importance which emerges from these histochemical observations is that the distribution of acid phosphatase activity as between the nucleus and the Golgi region of the prostatic

epithelial cell appears to be under control of the male sex hormone.

Furthermore, in histochemical preparations of some untreated subcutaneous homografts, the acid phosphatase can be seen to be, not in the normal epithelium but in the necrotic material within the lumina of the acini and in some connective tissue cells (Fig. 3). In such grafts which have been treated with methylcholanthrene, the reaction is confined to the dividing nuclei and is absent from the cytoplasm and from all but the nucleoli in the resting nuclei (Figs. 4 and 5). Again, none of these changes would be detectable biochemically. Fig. 6 shows a prostatic carcinoma which lost its glandular character after serial transplantations. Biochemical determinations showed a moderate content of acid phosphatase, but histochemical observations demonstrated that enzyme activity was absent from the tumour cells and was only present in the phagocytes of the stroma.

(2) Alkaline phosphatase. Alkaline phosphatase activity in the normal mouse prostate is largely restricted to the basement membrane, stroma underlying acini and in the endothelium of small blood vessels. It is entirely absent from the epithelium (Fig. 7). After castration, the reaction has largely disappeared from the basement membrane (Fig. 8), but has appeared in strength in the sheaths of the hyperplastic smooth muscle fibres of the stroma. The reaction has remained in the small blood vessels. A biochemical estimation of two such prostates may therefore show little change in total alkaline phosphatase activity despite these fundamental changes of distribution. A similar discrepancy is shown by Figs. 9 and 10. Fig. 9 is a prostatic autograft of a rabbit, and the alkaline phosphatase reaction can be seen mainly in the basement membrane, with a slight reaction in the nuclei and apices of some of the epithelial cells; in Fig. 10, however, which is an autograft of a shorter time, there is a reaction in the nuclei but none in the basement membrane.

It appears, therefore, that in experimental work on the prostate gland it is highly desirable to use histochemical preparations as a control of the biochemical estimations if the best use is to be made of the experimental material. This suggestion may also provide interesting results in the case of some other organs.

D. BRANDES
G. H. BOURNE

Department of Histology,
London Hospital Medical College,
London, E.1.
Dec. 16.

¹ See also Brandes and Bourne, *Brit. J. Exp. Pathol.*, [35, 577 (1954)].

Recovery of the Complementary Products of Mitotic Crossing-over

THE elegant analysis of mitotic crossing-over and segregation in *Drosophila melanogaster* by Stern¹ provided a model for comparison when an apparently similar process was observed by Pontecorvo *et al.* in diploid strains of *Aspergillus nidulans*, *Aspergillus niger* and *Penicillium chrysogenum*. The results obtained in *Aspergillus nidulans* have been entirely consistent with the interpretation by Stern; that is, mitotic crossing-over occurs such that at any one point only two of the four strands recombine and segregation of the centromeres is of the mitotic type².

Further support for this interpretation has now been obtained by the recovery, within a single diploid nucleus, of the reciprocal products of mitotic crossing-over. The technique used was based on recombination between alleles making use of the well-known position effect³ usually shown by allelic mutants originated by independent mutation ($\frac{m_1 +}{+ m_2}$ = mutant, $\frac{m_1 m_2}{+ +}$ = normal). We have assumed that, for the present purpose, crossing-over between alleles is not essentially different from that between non-allelic mutants.

A diploid *Aspergillus* (1) was prepared⁴ heterozygous for a number of linked markers and carrying in the *trans* arrangement the two allelic mutants *ad*₁₆ and *ad*₈. Phenotypes of the various haploid and diploid combinations of *ad*₁₆ and *ad*₈ are shown in Fig. 1. (For other markers, see ref. 5.)

If the supposed mechanism of mitotic crossing-over is correct, then two distinguishable types (2 and 3) of adenine-independent recombinants would be expected following a single mitotic cross-over between the *ad* alleles. Type 2 would result from the inclusion within the same nucleus of the reciprocal products of crossing-over. Type 3 would result from the inclusion within the same nucleus of the chromatid carrying the wild type *ad* alleles with the non-cross-over chromatid.

Conidia of diploid 1 (adenine-requiring) were plated on a medium lacking adenine, and adenine-independent diploids selected. These represented

only about 1 in 10⁷ of tested nuclei. The majority of the adenine-independent types were shown, by recovery and out-crossing of haploids, to have either genotype 2 or 3.

The determination of genotype with respect to the *ad* alleles was made possible by the fact that *ad*₁₆ and *ad*₈ determine slightly different phenotypes. The haploid double mutant *ad*₁₆*ad*₈ is phenotypically indistinguishable from the *ad*₈ type (that is, the most extreme mutant), but can be distinguished from it by out-crossing and recovering the less extreme type (*ad*₁₆). Similar results have also been obtained using alleles determining requirement for *p*-aminobenzoic acid⁶.

These results support the mechanism of mitotic crossing-over and segregation as outlined above. Furthermore, the technique used has led to the recovery of nuclei carrying two mutant alleles in the *cis* arrangement. The great difficulty of succeeding in this with nutritional mutants of micro-organisms is apparent⁷.

Whether one selects the complementary or non-complementary products of mitotic crossing-over, the technique outlined above offers an approach for the analysis of half-tetrads. One of us (R. H. P.) has already used the technique for this purpose.

This work is part of a programme of research supported by a grant of the Nuffield Foundation. One of us (R. H. P.) acknowledges a postgraduate grant from the Department of Scientific and Industrial Research.

J. A. ROPER

R. H. PRITCHARD

Department of Genetics,
University, Glasgow. Dec. 3.

¹ Stern, C., *Genetics*, 21, 624 (1936).

² Pontecorvo, G., Tarr Gloor, E., and Forbes, E., *J. Genet.*, 52, 226 (1954).

³ Lewis, E. B., "Adv. Genet.", 3, 73 (1950).

⁴ Roper, J. A., *Experientia*, 8, 14 (1952).

⁵ Pontecorvo, G., "Adv. Genet.", 5, 141 (1953).

⁶ Roper, J. A., "Adv. Genet.", 5, 208 (1953).

⁷ Haldane, J. B. S., "The Biochemistry of Genetics", 113 (George Allen and Unwin, 1954).

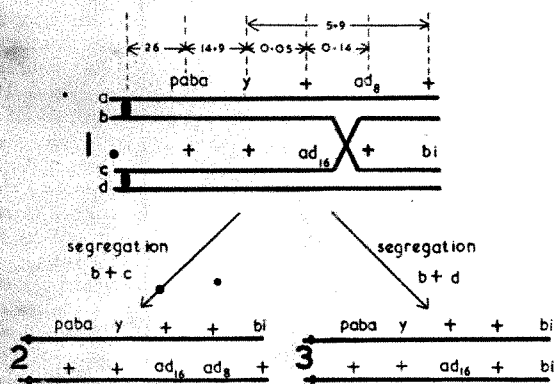


Fig. 1. Origin of recombinant nuclei. Distances in centi-Morgans

Strain	Phenotype on minimal medium
<i>ad</i> ₁₆ +	reduced growth
+ <i>ad</i> ₈	no growth
<i>ad</i> ₁₆ <i>ad</i> ₈	no growth
<i>ad</i> ₁₆ +	reduced growth
+ <i>ad</i> ₈	
<i>ad</i> ₁₆ <i>ad</i> ₈	full growth
+ +	

Vibrations of the Substrate and Stridulation in a Grasshopper

OBSERVATIONS made during experiments to determine the behaviour associated with stridulation in *Chorthippus parallelus* (Zett.) (Orthoptera, Acrididae) suggested that, in certain cases, females the tympanal organs of which had been destroyed were reacting to vibrations of the substrate caused by the act of stridulation in the male. Since it has been shown by Autrum¹ that Orthopteroid insects possess a receptor, the so-called sub-genual organ, which is sensitive to vibration, it was thought that preliminary experiments to determine whether a stridulating insect does produce any measurable vibration of the substrate would be of interest.

Adult mature males of *C. parallelus* were placed on hard-packed bare earth in a large metal tray mounted on thick sponge rubber. A 'Rothenmel' vibration pick-up, type V.P.6, was suspended in sponge rubber so that its tip just touched the soil, the centre of the insect arena being 15 cm. from the pick-up. The latter fed into a high-gain amplifier with variable band-pass filters, the output of which was displayed on one trace of a double-beam oscilloscope. The other beam of the oscilloscope was fed

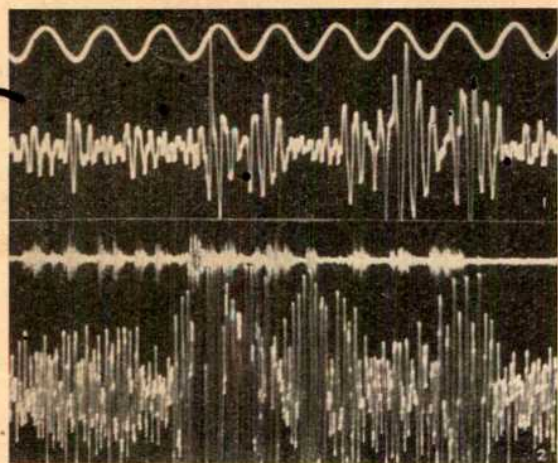


Fig. 1. Vibrations of 300 c./sec. set up by insect landing after a jump of 12 cm. Timing wave, 50 c./sec.

Fig. 2. Upper trace shows stridulation of male *Chorthippus parallelus*, and lower trace 500 c./sec. vibrations in substrate resulting from some of the sound pulses

from an audio-amplifier and a microphone, the latter being suspended over the insect arena. This arrangement permitted the direct observation and recording of stridulation and substrate vibrations produced by it.

The gain necessary to detect feeble vibrations produced high background noise; also, experiments had to be done at night, when extraneous vibration was at minimum level. The insects, with artificial heat and light, stridulated normally and also moved about freely in the arena both by walking and jumping. The former movement caused no detectable vibration, but the latter produced well-defined vibrations the frequency of which was 250–300 c./sec., with a maximum displacement of the order of 120 μ . Fig. 1 shows an oscillograph of such vibrations, produced by the landing of an insect after a short jump of 10–12 cm. length.

Vibrations produced as a result of stridulation were so difficult to detect that it was at first thought that no measurable displacement was set up. But in a few cases, when the insect was within 6 cm. of the tip of the pick-up, definite displacements were observed; and although background noise was very high, vibrations clearly connected with stridulation were recorded. The lower trace of Fig. 2 shows an oscillograph of such vibration, the top trace being the sound pattern of the stridulation, showing the repetitive pulses typical of the species. It will be seen that the first few sound pulses do not appear to cause vibrations, although their amplitude is as high as the remaining pulses which do; the evidence available cannot explain this effect. The frequency of these vibrations is between 400 and 500 c./sec., and the maximum displacement represented is of the order of 20 μ . This displacement is above the threshold, at the given frequency, of the sub-genual organ of Acrididae, as reported by Autrum and Schneider²; their work shows that at 400–500 c./sec. the organ in the hind leg of certain Acrididae (species not given) responds to substrate vibrations of the order of 10 μ . Thus it seems probable that some Acrididae can detect the presence of a stridulating insect a short distance away, although the range will depend largely on the type of substrate and its attenuating effect on the vibrations.

It must also be remembered that the stridulation noise of Acrididae contains component frequencies up to about 10 kc./sec., and these may induce high-frequency vibrations in the substrate. These could not be detected in the present experiments as they are beyond the useful frequency-range of the apparatus. It is interesting to note, however, that it is at such high frequencies, according to Autrum and Schneider, that the sub-genual organs attain their maximum sensitivity; in Acrididae, for example, sensitivity at 3,000 c./sec. is of the order of 0.9 μ . Against this must be set the fact that high-frequency vibrations would be subject to great attenuation by the substrate and therefore might not give a large increase in the possible range of detection.

Further work with more sensitive apparatus of wider frequency-range, with suitable precautions against extraneous vibration, is needed to clarify the possible range of communication by this method, and to investigate the possible existence of modes of vibration characteristic of particular stridulating insects.

I am indebted to Mr. Taylor-Smith, of the Department of Geophysics, Imperial College, for the loan of the vibration pick-up and amplifier.

P. T. HASKELL

Department of Zoology and Applied Entomology,
Imperial College Field Station,
Silwood Park, Sunninghill, Berks.
Dec. 14.

¹ Autrum, H., *Z. vergleich. Physiol.*, 28, 580 (1941).

² Autrum, H., and Schneider, W., *Z. vergleich. Physiol.*, 31, 77 (1948).

Plant Mitochondria and Salt Accumulation

THE participation of a cytochrome oxidase system in salt respiration and salt accumulation was first suggested by Lundegårdh¹. Robertson and Wilkins² presented quantitative evidence which was consistent with the hypothesis that the mechanism of accumulation depends on the cytochrome system. Recent studies have associated the cytochrome system with the mitochondria, and Robertson³ suggested that mitochondria might be associated with the accumulation mechanism. Accumulation of cations in animal mitochondria has been demonstrated by Bartley and Davies⁴, Macfarlane and Spencer⁵ and Stanbury and Mudge⁶. Bartley and Davies also demonstrated that phosphate and organic anions were accumulated in mitochondria.

Mitochondria isolated by centrifugation from carrot and beet tissues and transferred from one isotonic solution to another containing a different concentration of chloride adjust themselves to a new internal chloride concentration with a half-time of about 3 min. Experiments on the time of adjustment have been used to calculate the apparent diffusion constant of salt in the mitochondrial membrane, assumed to be 200 Å. in thickness as suggested by Farrant, Robertson and Wilkins⁷. The apparent diffusion constant is about 10^{-13} cm.²/sec., which is similar to that found in heart muscle sarcosomes prepared under similar conditions (K. W. Cleland, personal communication, 1954) and is of the order of magnitude expected for a lipo-protein membrane.

The mitochondria do not reach equality of concentration with the external solution, but maintain a higher internal concentration of both mobile cations and mobile anions. The results of a number of experiments have been grouped in Table 1.

Table 1. CONCENTRATIONS OF SODIUM, POTASSIUM AND CHLORIDE IN BEET MITOCHONDRIAL PELLETS IN M.MOLE/L. Means, with standard errors and number of observations given in brackets

Na ⁺ concentration		K ⁺ concentration		Cl ⁻ concentration	
External	Internal	External	Internal	External	Internal
0-6	22.8 ± 2.6 (12)	0-6	11.0 ± 0.8 (17)	0-2	4.9 ± 0.6 (11)
7-13	39.6 ± 3.9 (16)	7-13	20.6 ± 1.9 (5)	5-12	11.7 ± 0.7 (11)
79-85	88.1 ± 2.6 (4)	14-20	21.3 ± 1.6 (5)	13-20	16.9 ± 0.6 (18)
				45-47	38.7

The high concentration of mobile cations can be explained by a Donnan equilibrium with the immobile anions (proteins, phospholipids, etc.) in the mitochondria. Such an equilibrium would be accompanied by a lower internal concentration of chloride unless there were: (a) combination of either the mobile cations or mobile anions so that they are removed from solution; (b) two distinct phases, one with the mobile cations held by immobile anions and another with mobile anions held by immobile cations; or (c) a mechanism dependent on the oxygen uptake to accumulate the chloride against the concentration gradient.

While (a) and (b) cannot be excluded, (c) was investigated by comparing concentration of chloride maintained in the steady state with the oxygen uptake of the mitochondria. With no added substrate there was a positive correlation ($r = 0.913$, $p < 0.01$). Further, by using the apparent diffusion constant, the leakage-rate for a given concentration difference and hence the accumulation-rate required to maintain the concentration difference can be calculated. A concentration difference of 3 m.mole/l. would require an accumulation-rate of 4.5×10^{-6} gm./mol. chloride ion/pellet of 0.14 gm./hr. The oxygen uptakes observed were of the right order of magnitude to maintain this accumulation-rate if one anion was accumulated each time an electron traversed the cytochrome system, that is, about 1×10^{-6} gm. mol. oxygen/pellet/hr.

Thus the results are consistent with the hypothesis that the anions in the mitochondrion might be accumulated by the electron carrier of respiration acting as the anion carrier of accumulation. The mitochondria in the intact cell, capable of accumulating anions themselves, could act as vehicles for the passage of ions from cell-surface to vacuole.

This work was part of the joint programme of the Division of Food Preservation, Commonwealth Scientific and Industrial Research Organization, and Botany School, University of Sydney, and a fuller account will be published elsewhere¹.

R. N. ROBERTSON
MARJORIE J. WILKINS
A. B. HOPE

Plant Physiology Unit,
Division of Food Preservation and Transport,
Commonwealth Scientific and
Industrial Research Organization,
and Botany School,
University of Sydney.
Dec. 9.

¹ Lundegårdh, H., *Ann. Agric. Coll., Sweden*, **8**, 234 (1940).

² Robertson, R. N., and Wilkins, M. J., *Aust. J. Sci. Res.*, **1**, 17 (1948).

³ Robertson, R. N., "Ann. Rev. Plant Physiol.", **2**, 1 (1951).

⁴ Bartley, W., and Davies, R. E., *Biochem. J.*, **52**, xx (1952); **57**, 37 (1954).

⁵ Macfarlane, M. G., and Spencer, A. G., *Biochem. J.*, **54**, 569 (1953).

⁶ Stanbury, S. W., and Mudge, G. H., *Proc. Soc. Exp. Biol. and Med.*, **82**, 675 (1953).

⁷ Farrant, J. L., Robertson, R. N., and Wilkins, M. J., *Nature*, **171**, 401 (1953).

⁸ Robertson, R. N., Wilkins, M. J., Hope, A. B., and Nestel, L., *Aust. J. Biol. Sci.* (in the press).

Occurrence of the Black Rat in Sewers in Britain

It had been supposed for a long time that the ship or 'black' rat, *Rattus rattus* L., did not occur in sewers in Britain. There was a record from the sewers of Lima, Peru¹, but no such records existed for the United Kingdom.

Recently, *R. rattus* has been taken alive from the sewers of three localities in England. The first of these was in Wandsworth Metropolitan Borough in the County of London. Sewermen had known for the past two years that "some of the rats down there were like bats without wings", and recently two live ship rats were caught and their identities confirmed.

I then suggested that the lack of records might be fortuitous, due merely to the lack of observation, and that other records would be made if a definite search were undertaken. Shortly after this, another live ship rat was taken from the sewers of Liverpool County Borough, and within the past few weeks, two live ship rats have been trapped in the sewers of Ramsgate Municipal Borough. Remains of dead ones have also been found.

Thanks are due to the local authorities mentioned, for their co-operation with this Ministry's staff.

R. A. DAVIS

Infestation Control Division,
Ministry of Agriculture and Fisheries,
Hook Rise,
Tolworth, Surrey.
Dec. 7.

¹ Eskey, C. R., Epidemiological Study of Plague in Peru, U.S.A., Pub. Health Rep., **47**, 2191-2207 (Nov. 18, 1932).

The Rostrum of *Centrocnemis* Signoret 1852

In the classification of the group Heteroptera, the number of segments in the labium was formerly considered to vary. Closer investigation has revealed, however, that all Heteroptera possess a labium composed of four segments.

In the Reduviidae all genera, with one exception, so far as is known, have only three visible segments in the labium, the first segment (or actual basal segment) being very feebly sclerotized and concealed within the head. The exception is the genus *Centrocnemis* Signoret (Hemiptera-Heteroptera: Reduviidae-Reduviinae). In this genus the basal segment is relatively large, strongly sclerotized and distinct. There are tubercles on it which may possibly be vestigial labial palpi. The labrum, moderately long and narrowly triangular, extends to just beyond the base of the second rostral segment. Its base is almost concealed by two of the tubercles on the first rostral segment, which converge over it.

Centrocnemis is included, at present, in the subfamily Reduviinae. In a forthcoming revision, I propose to remove it and to create a new subfamily for its reception, since, apart from its distinctive

rostrum, it has other characters which would justify this action.

N. C. E. MILLER

Commonwealth Institute of Entomology,
c/o British Museum (Natural History),
London, S.W.7.

Light Sensitivity of the Aquatic Flatworm *Dendrocoelum lacteum*

WE have measured in various parts of the spectrum the amounts of radiation necessary to elicit in the planarian *Dendrocoelum lacteum* a characteristic response, namely, movement away from a source of light¹. In each trial, one animal was dropped into a square 'Perspex' tank (50 cm. $\times$ 50 cm., 10 cm. deep) filled with lake water, in front of a calibrated source of spectral radiation placed outside the tank (opal electric bulb, 'neutral' wedges and colour filter²). *D. lacteum*, being milky-white in colour, could readily be detected with a red electric torch against the background of black paper placed under the tank. After 3 min. the torch was switched on and it was seen whether the animal had moved at least 10 cm. away from the light source in approximately the right direction. If so, this was taken as a positive response. The animal's movements were too slow for the observations to be appreciably affected by the light of the torch. In control experiments in which the colour filter was replaced by a piece of opaque cardboard, the number of animals giving a positive response was insignificant.

Trials were made with a number of animals using various spectral bands in the 'visible' range and a band around 0.37μ in the near ultra-violet. For each spectral band, that intensity at which five out of the seventeen experimental animals responded was taken as the average threshold value. The individual thresholds varied considerably from one animal to another, and the accuracy which could be reached was markedly less than in the case of human vision. The sensitivity was a maximum in the neighbourhood of 0.5μ ; this seems in general agreement with the maximum near 0.53μ found by Viaud³ in studies made, at higher intensities, of the orientation reactions of planarians having eyes.

The spectral sensitivity curve was found to be roughly similar to that of rod vision in the human aphakic eye⁴—that is, an eye from which the lens has been removed. As the lens is responsible for the greater part of the light losses in the preretinal media of the human eye, the curve for *D. lacteum* must bear a general resemblance to the sensitivity curve of the human rod receptors. It should therefore also resemble the spectral absorption curve of the visual pigment rhodopsin; but it must be borne in mind that there is a discrepancy between the latter curve and the rod sensitivity curve at the violet end of the spectrum⁵.

Relatively to the sensitivity to 0.51μ , the sensitivity to radiation of about 0.37μ was roughly a thousand times greater in *D. lacteum* than in the normal human eye with a lens. For this wavelength animals responded at an illumination at which they were quite invisible in the experimental tank to the dark-adapted, normal, human eye. The electric lamp itself, viewed through the 0.37μ filter, was then barely visible—although it would, of course, have looked much brighter to an aphakic eye. In parts of the spectrum other than the near ultra-violet, violet and blue, the animals, when the illumination

was high enough to elicit a positive response, could generally just be seen by the dark-adapted, normal, human eye.

D. lacteum possesses two small but well-defined eyes, one on each side of the head. Taliaferro's experiments⁶ on other species of planarians showed that the reaction studied here was mediated through the eyes—while also suggesting that the individual sense-cells may possess a remarkable directional sensitivity. Assuming, then, that in the present case the reaction is mediated entirely through the eyes, and that the diameter of the effective pupil of the eye is a circle 0.08 mm. in diameter, we calculate on the basis of absolute calibrations of the apparatus that five out of seventeen experimental animals responded in one series of experiments to an energy flux corresponding to about 40,000 quanta ($\lambda = 0.52\mu$) per eye per sec., and in another series to about 4,000 quanta, or 15×10^{-9} erg, per eye per sec.

In the case of man, the minimum flux of radiation which must enter the pupil of the eye for a small continuous light source to be seen is of the order of 750 quanta (0.51μ), or 3×10^{-9} erg, per sec.⁷. Thus the organisms studied here would have an absolute sensitivity close to that of the human eye. Artificial light-detectors of similar sensitivity (photo-multipliers with ancillary apparatus) might weigh about a million times as much as one specimen of *D. lacteum*. As stated, however, this discussion of absolute values rests on the assumption that the reaction is mediated entirely through the eye; experiments are in preparation to verify this assumption directly.

We are greatly indebted to Mr. H. C. Gilson, director of the Windermere Laboratory of the Fresh-water Biological Association, for facilities to carry out these experiments in his laboratory. The apparatus used was acquired through the support of the Nuffield Foundation and the Medical Research Council. One of us (F. H. C. M.) is the recipient of a Nuffield Foundation Biological Scholarship.

M. H. PIRENNE

F. H. C. MARRIOTT

Physiology Department,
Marischal College,

University of Aberdeen. Dec. 10.

¹ Uilyott, P., *J. Exp. Biol.*, **13**, 252 (1936).

² See Denton, E. J., and Pirenne, M. H., *J. Physiol.*, **123**, 417 (1954); **125**, 181 (1954).

³ Viaud, G., "Année Biologique", **27**, 365 (Paris, 1951).

⁴ Wald, G., *Science*, **101**, 653 (1945).

⁵ Stiles, W. S., *Trans. Opt. Convent. Worshipful Company of Spectacle Makers*, 97-107 (Spectacle Makers Company, London, 1948).

⁶ Taliaferro, W. H., *J. Exp. Zool.*, **31**, 59 (1920).

⁷ Walsh, J. W. T., "Photometry" (2nd edit., London, 1953).

An Asymmetrical Response of Teleost Melanophores

Ballowitz¹, Wyman² and others have described several nerve fibres innervating the individual melanophores of Teleosts, and it is now generally accepted that these nerves are of autonomic origin. Whether the melanophore innervation is single, involving aggregating fibres only, or double, including an antagonistic set of dispersing fibres, is still a matter of opinion (Parker³).

As a rule, section of a few melanophore nerve fibres in a white-adapted teleost fish causes an area of the related melanophores to disperse, the melanin granules being symmetrically distributed in the melanophore processes. Each of the surrounding

innervated melanophores remains symmetrically aggregated. In the course of numerous experiments on the minnow (*Phoxinus phoxinus* L.), I have repeatedly observed melanophores on the border of a denervated area with processes directed towards the fully denervated melanophores in the dispersed state, and processes directed towards the innervated area in a much more aggregated state (Fig. 1).

This asymmetrical response in Teleosts has not, to my knowledge, been previously reported. It is not peculiar to the minnow, but is easily seen, for example, on the borders of denervated melanophore areas in *Gobius paganellus* (Fig. 2) and *Gasterosteus aculeatus* (Fig. 3).

Several workers have made detailed studies on denervated teleost melanophores (cf. Parker³), especially in *Ameiurus nebulosus*, without reporting any marginal asymmetrical response. High magnification shows the response to be present in this Teleost, though it occurs less frequently than in the other Teleosts investigated. Fig. 4 shows at *a* the asymmetrical response in a large dermal melanophore and at *b* the response in two of the smaller epidermal melanophores of *Ameiurus*.

If the nerve fibres innervating the melanophores are entirely aggregating, then the asymmetrical response takes place because those fibres innervating the more dispersed side of the melanophore have been severed, whereas those serving the more aggregated side continue to operate in the white-adapted fish. However, Parker³ believes that the teleost melanophore innervation is double and that nerve section causes an active stimulation of the dispersing fibres without affecting the aggregating ones. If this is so, then the asymmetrical response is caused by the dispersing fibres activating one part of the melanophore, and aggregating fibres antagonistically activating another part of the same melanophore. In either case, if the melanophore is a single effector

cell, the situation arises of such a cell doing one thing in one half and a different thing in the other.

Parker³ has suggested that the double innervation of melanophores involves the release of adrenaline or acetylcholine at the nerve-fibre endings, just as in other autonomically innervated effectors. If this is so, it seems that these neurohumours produce two localized effects on the surface of the melanophore. It seems probable that melanophore effector cells are so comparatively large that several nerve fibres have, of necessity, become the established innervation in evolution, to bring about a complete response.

A more detailed account of teleost melanophore denervation experiments will be published elsewhere. Acknowledgments are due to Dr. E. G. Healey for supervision and to the Medical Research Council for a research scholarship.

E. G. GRAY

Department of Zoology,
University College of Wales,
Aberystwyth. Dec. 4.

¹ Ballowitz, E., *Z. wiss. Zool.*, **56**, 673 (1893).

² Wyman, L. C., *J. Exp. Zool.*, **39**, 73 (1924).

³ Parker, G. H., "Animal Colour Changes and their Neurohumours" (Camb. Univ. Press 1948).

Influence of Dietary Antibiotic Supplements on the Visceral Weights of Pigs

GORDON¹ showed that a dietary antibiotic supplement of 50 parts per million of procaine penicillin or terramycin in the food of chicks produced a significant reduction in the weight of the small intestine. The weights of the liver and spleen were not affected.

The present results were obtained from 75 Large White pigs, slaughtered at approximately 200 lb. live-weight, in an antibiotic feeding experiment. The

pigs were arranged in fifteen pens of five, three pens being fed a basic ration, six the basic ration plus various doses of aureomycin hydrochloride, and six the basic ration plus various doses of procaine penicillin; the average amount of both antibiotics was 30 parts per million in the food. Table 1 shows the mean weights of the evacuated sections of the digestive tract, liver and spleen in control, aureomycin and penicillin-fed animals. Table 2 gives the significance levels of the various differences.

The weights of the stomach, caecum and large intestine were not significantly affected by the administration of either antibiotic. The small intestine was significantly lighter in the aureomycin-fed animals, but there was only a slight, non-significant, reduction in this weight in the penicillin-fed animals. Aureomycin also produced a significant reduction in the weight of the spleen, which was not found in the penicillin-fed animals. The livers of the penicillin-fed animals were considerably heavier than those of the controls, whereas aureomycin pro-

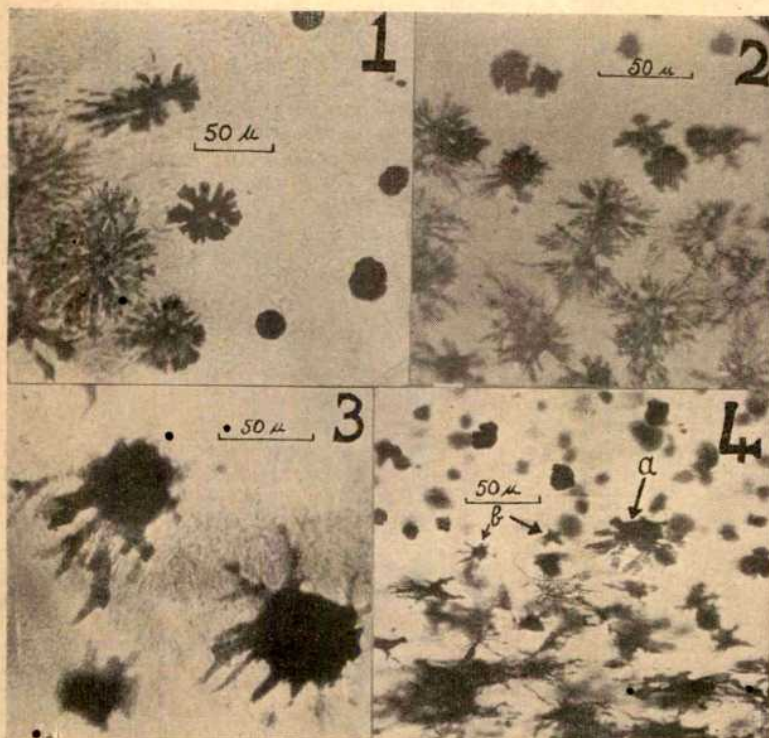


Table 1. AVERAGE WEIGHTS (IN GRAMS) OF STOMACH, SMALL INTESTINE, CÆCUM, LARGE INTESTINE, LIVER AND SPLEEN OF THE CONTROL, AUREOMYCIN- AND PENICILLIN-FED ANIMALS

Treatment	No. of pigs	Stomach	Small intestine	Cæcum	Large intestine	Liver	Spleen
Control	15	865	2,092	179	1,712	2,121	153
Aureomycin	30	856	1,823	164	1,715	2,044	133
Penicillin	30	885	1,973	176	1,661	2,296	147

Table 2. SIGNIFICANCE LEVELS OF THE DIFFERENCES BETWEEN CONTROL AND THE AUREOMYCIN GROUP, BETWEEN CONTROL AND THE PENICILLIN GROUP AND BETWEEN THE AUREOMYCIN AND PENICILLIN GROUPS

Comparison	Stomach	Small intestine	Cæcum	Large intestine	Liver	Spleen
Control v. aureomycin	N.S.	+++	N.S.	N.S.	N.S.	++
Control v. penicillin	N.S.	N.S.	N.S.	N.S.	+	N.S.
Aureomycin v. penicillin	N.S.	++	N.S.	N.S.	+++	+

N.S. = Not significant; + = $p < 0.05$; ++ = $p < 0.01$; +++ = $p < 0.001$

duced a (non-significant) reduction in the weight of the liver.

The total weight of the organs considered was considerably greater in the penicillin-fed animals than in those fed with aureomycin. This may partially explain the significantly greater dressed-carcass weights (allowing for live weight) of the aureomycin-fed animals compared with the penicillin-fed animals, noted in this and two other experiments by Harrington and Taylor².

The differing effects of aureomycin and penicillin on the weights of the small intestine, liver and spleen suggest that their modes of action may be different; histological examination of the livers and spleens has, however, not revealed any consistent changes to which the variations in weight of these organs could be attributed.

J. H. TAYLOR

Agricultural Research Council
Field Station, Compton,
Nr. Newbury,
Berks.

G. HARRINGTON

Agricultural Research Council
School of Agriculture,
Cambridge.

¹ Gordon, H. A., Report of a Colloquium held on June 4, 1952, at the Lobund Institute, Notre Dame, Indiana (1952).

² Harrington, G., and Taylor, J. H., *J. Agric. Sci.* (in the press).

Ionization in Fatty Acid Monolayers on Pure Water

EXPERIMENTS recently carried out in this laboratory suggest that previous determinations of some important properties of monolayers of long-chain fatty acids on water surfaces have been misinterpreted. Former measurements of force-area characteristics¹⁻³ and surface potentials⁴ show well-defined changes occurring at about the pH at which the carboxyl group is expected to be appreciably ionized, and these changes have been ascribed to the ionization⁵. We have found that the effects can be caused by impurities in the substrate and that, in fact, ionization has much less effect on the properties of stearic acid monolayers than has been thought previously.

Fig. 1 shows results from $(\pi - A)$ measurements over the pH range 2-9 with stearic acid films on water of increasing degrees of purity. In the graph, σ_0 , the area/molecule at 'zero' compression (that is, at the pressure at which an increase in film pressure

is first observed as the film is compressed) (unpublished results) is plotted against pH. The values of σ_0 were obtained from $(\pi - A)$ curves determined in the usual manner on a Langmuir-Adam surface balance. The pH of the substrate was adjusted by the addition of hydrochloric acid or ammonium hydroxide, and no attempt was made to keep the ionic strength constant. Measurements made before and after each $(\pi - A)$ determination showed that the pH remained constant over this time to within ± 0.1 pH unit. Films were left for at least five minutes on the water surface before they were compressed.

On the purest water, there was no significant variation of the $(\pi - A)$ curves over the whole of the pH range. Thus σ_0 remains constant, as seen in curve 1 (Fig. 1). The water used in this experiment was derived from a very soft tap water (Melbourne city supply) by distillation in a tin-lined still and then in an all-Pyrex still. The latter consisted of a 3-litre boiling flask surmounted by a splash head connected to a vertical water condenser by an almost horizontal air condenser 22 cm. long. The outlet from the splash head was at least 45 cm. above the level of the water in the boiling flask. The electrical conductivity of the purified water was $1 \times 10^{-6} \Omega^{-1} \text{ cm}^{-1}$.

Curves II, III and IV were obtained with the successive distillates from a typical hard water obtained from a limestone quarry near Geelong (Victoria). The distillations were carried out carefully in a 'Pyrex' still of the same design and dimensions as that used for the second distillation of the Melbourne water. Curve V was obtained with $M/2,000$ calcium chloride solution. Curves II-V all show a decrease in σ_0 with increase of pH. Previous work has shown that with $M/2,000$ calcium ion solutions the depression in σ_0 at pH 6 is caused by the formation of calcium stearate (unpublished results). The results immediately suggest that the behaviour of films on the once-distilled hard water (curve II) is caused by alkaline earth impurities in the water. The total calcium content of the Geelong and Melbourne water sources is reported to be 68 and 2 parts per million respectively⁶, the latter value being particularly low for a city water supply.

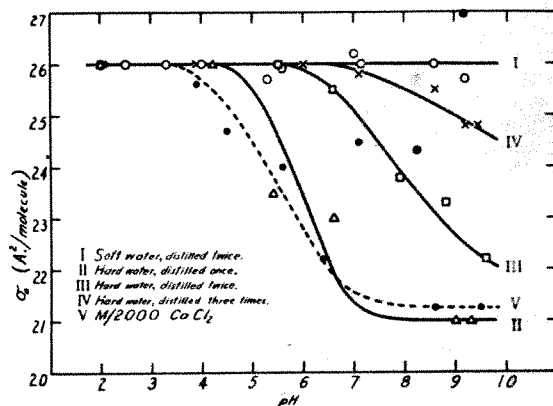


Fig. 1. Effect of the purity of water on monolayers of stearic acid. Variation of σ_0 , the area per molecule at zero compression, with pH.

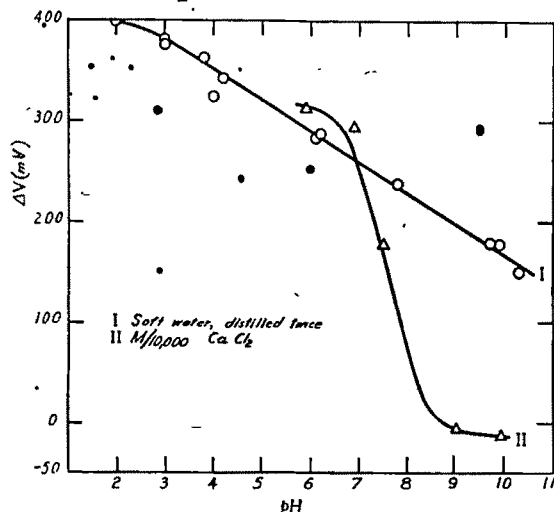


Fig. 2. Dependence of surface potential on pH for compressed monolayers of stearic acid on pure water and on a dilute solution of calcium chloride

The increase in purity produced by successive distillations of the hard water is seen from the way in which curves III and IV approach curve I. However, even after the third distillation, sufficient calcium is still present to cause a slight depression in σ_0 at high pH values.

Surface potential measurements, made with a radioactive electrode under the same conditions as the $(\pi - A)$ curves, gave the results presented in Fig. 2. The values of ΔV are the potentials, no longer dependent upon pressure, obtained when the film is compressed to an area/molecule less than σ_0 . The films behaved reversibly, and the measurements were reproducible to within about 10 mV. With the purest water, ΔV decreases apparently linearly from +400 mV. at pH 2 to +170 mV. at pH 10. With a very dilute solution of calcium chloride, ΔV drops suddenly at pH 7 to a slightly negative value at pH 9 (curve II, Fig. 2). This curve is strikingly similar to previously published $(\Delta V - pH)$ curves⁴ in which the sudden drop in ΔV has been ascribed to ionization. This similarity suggests that unsuspected impurities reacting with the acid to form a soap are also responsible for the more negative potentials observed by other workers at high pH values. These workers, however, used buffered solutions of much greater ionic strength than those used in our own experiments.

The results show that of itself ionization in the monolayer has no appreciable effect on the $(\pi - A)$ characteristics of stearic acid, and a much smaller effect on the surface potential than previously supposed. It is also demonstrated that if a hard water is to be purified by distillation, the process must be carried out carefully and repeatedly before the effects of dissolved impurities on the properties of acid monolayers can be eliminated.

J. V. SANDERS
J. A. SPINK

Division of Tribophysics,
Commonwealth Scientific and
Industrial Research Organization,
University of Melbourne. Dec. 20.

- ¹ Lyons, C. G., and Rideal, E. K., *Proc. Roy. Soc., A*, 124, 323 (1929).
² Maraden, J., and Schulman, J. H., *Trans. Farad. Soc.*, 34, 748 (1938).
³ Sasaki, T., and Matsumura, R., *Bull. Chem. Soc. Japan*, 24, 274 (1951).
⁴ Schulman, J. H., and Hughes, A. H., *Proc. Roy. Soc., A*, 138, 436 (1932).
⁵ Glazer, J., and Dogan, M. Z., *Trans. Farad. Soc.*, 49, 448 (1953).
⁶ Anderson, V. G., *J. and Proc. Aust. Chem. Inst.*, 7, 187 (1940).

Proton Magnetic Resonance Spectra of Coals

PROTON magnetic resonance spectra can give information about the arrangement of the hydrogen atoms in a solid¹. Preliminary measurements have been made which suggest that this method may provide useful information about the distribution of hydrogen atoms in coal.

Samples were prepared from hand-selected lumps of bright coals containing more than 50 per cent vitrain. The samples were ground into cylinders of 6.25 mm. diameter $\times$ 3 cm. long, the axis of the cylinder lying in the bedding plane. Part of the inherent moisture content of the samples was removed by heating them to 80° C. under a pressure of 0.2 mm. of mercury for 4 hr. The samples were then sealed into glass tubes to prevent resorption of moisture. Nuclear resonance measurements were made at 90° K. using the apparatus described by Richards and Smith² and by Pratt and Richards³.

The second moments of the proton resonance absorption lines were obtained for three samples and are given in Table 1, together with the constitution of the coals. A slight anisotropy of line shape with orientation of the sample in the magnetic field was observed with the Llandebie, but not with the other coals.

Table 1

Coal	N.C.B. Code No.	Percentage constitution				Second moment (gauss) ²
		Moisture	Carbon	Hydrogen	Ash	
Llandebie Monk Breton	100a	1.5	92.6	2.8	1.1	16
Langwith	602	3.2	83.1	5.2	0.4	19½
	902	4.8	79.2	5.3	1.2	21½

One interpretation of the variation in second moment would be in terms of a variation in the ratio of the number of hydrogen atoms present in saturated hydrocarbon chains or rings to the number of hydrogen atoms attached to aromatic or graphitic structures. Proton resonance spectra of aromatic hydrocarbons have second moments⁴ of about 10 gauss² and aliphatic hydrocarbons give spectra with second moments⁵ of about 26 gauss². On this interpretation the relative proportion of aliphatic protons increases as the carbon content of the coal decreases. X-ray diffraction investigations⁶ on coal samples suggest that the graphitic or aromatic structure increases with increasing rank.

One of us (P. C. N.) wishes to thank the Director-General of Research, National Coal Board, for permission to publish this communication; the views expressed are not necessarily those of the Board.

P. C. NEWMAN

Central Research Establishment I,
National Coal Board,
Stoke Orchard, Glos.

L. PRATT
R. E. RICHARDS

Physical Chemical Laboratories,
Oxford.
Feb. 8.

- ¹ Purcell, E. M., *Science*, 118, 431 (1953).
² Richards, R. E., and Smith, J. A. S., *Trans. Farad. Soc.*, 47, 1261 (1951).
³ Pratt, L., and Richards, R. E., *Trans. Farad. Soc.*, 49, 744 (1953).
⁴ Andrew, E. R., and Eades, R. G., *Proc. Roy. Soc., A*, 218, 537 (1953).
⁵ Andrew, E. R., and Eades, R. G., *Proc. Roy. Soc., A*, 216, 398 (1953).
⁶ Andrew, E. R., *Physica*, 17, 405 (1951).
⁷ Hirsch, P. B., *Proc. Roy. Soc., A*, 226, 143 (1954).

Excitation Processes and the Theory of the Arc Discharge

No satisfactory theory exists to account for the current transfer at the cathode of an arc the cathode material of which has a low boiling point, such as mercury or copper. Whereas thermionic emission can account for the mechanism of arcs with cathodes of high boiling point, such as carbon and tungsten, this seems highly improbable for substances which boil far below their emitting temperature. Field emission of electrons¹, current transfer by positive ions only², and other suggestions³ have been made; but they cannot account for both the observed high current densities⁴ of order 10^6 A./cm.^2 and the low cathode fall, which can be smaller than the ionization potential of the cathode material⁵.

A new theory is proposed in which electrons are released from the cathode by excited atoms the potential energy of which exceeds the work function. The intensely luminous 'cathode spot' suggests that, immediately above the current-carrying area of the cathode, there is a region of excited metal vapour the density of which is many orders of magnitude greater than elsewhere in the arc. There is a net flow of neutral atoms through this region which can be regarded as the difference between the gross cathode evaporation and the return of atoms to the cathode by back-scattering. Most of the returning atoms will be excited, but because of the short distance they have to travel they will reach the cathode surface before they have time to radiate. Consequently they will behave like metastable atoms, which are known to cause emission of electrons with a very high yield⁶. The emitted electrons gain energy in the cathode fall, which is so small that they can only produce excitation of the vapour and then carry the arc current into the adjoining positive column. Ionization in the vapour will occur by collisions between excited atoms. The positive ion current to the cathode need only be sufficient to provide the space charge for the cathode fall and supply energy for evaporation. The presence of a foreign gas should not affect appreciably this cathode mechanism.

Known measurements⁷ on a mercury arc give a rate of evaporation of $3 \times 10^{-4} \text{ gm./coulomb}$; for a current density of 10^6 amp./cm.^2 , this is equivalent to 10^{24} atoms/ cm.^2 and sec. The gross evaporation and hence back-scattering may be at least an order of magnitude greater, namely, 10^{25} atoms/ cm.^2 and sec. If most of the latter are excited, such a flow should be ample to release 10^6 amp./cm.^2 of electrons from the cathode.

The cathode fall can be estimated from a balance of the rates of production and loss of excited states in the cathode spot. The losses include radiation, ionization, diffusion towards the positive column and, most of all, back-diffusion to the cathode. If the latter accounts for at least half the total loss, then the cathode fall would be less than twice the principal excitation potential of the cathode vapour. For mercury this excitation potential is 4.9 V., and thus the cathode fall should be rather less than 10 V., as observed.

The proposed model is in accord with a previous theory of the retrograde motion of cathode spots in transverse magnetic fields⁸. In addition, it is proposed that the high current density in arc spots is due to the self-magnetic field operating in the ionized vapour. A detailed treatment of the contraction

and the emission processes will appear in the near future.

This communication is published by permission of the Director of the Electrical Research Association.

A. E. ROBSON
A. VON ENGEL

Clarendon Laboratory,
Oxford. Feb. 9.

¹ Langmuir, I., *G.E. Rev.*, 26, 735 (1923).

² Slepian, J., *Phys. Rev.*, 27, 407 (1926). Weizel, W., Rompe, R. and Schon, M., *Z. Phys.*, 115, 179 (1940).

³ Smith, C. G., *Phys. Rev.*, 62, 48 (1942). Rothstein, J., *Phys. Rev.*, 73, 1214 (1945).

⁴ Froome, K. D., *Proc. Phys. Soc.*, 60, 424 (1948); B62, 805 (1949); B63, 377 (1950). Somerville, J. M., and Blövin, W. R., *Phys. Rev.*, 76, 932 (1949).

⁵ Lamar, E. S., and Compton, K. T., *Phys. Rev.*, 37, 1069 (1931).

⁶ See Massey, H. S. W., and Burhop, E. H. S., "Electronic and Ionic Impact Phenomena", 565 (Oxford, 1952). Gurovich, I. M., and Yavorski, B. M., *C.R. Acad. Sci. U.R.S.S.*, 53, 789 (1946).

⁷ Tonks, L., *Phys. Rev.*, 54, 634 (1938).

⁸ Robson, A. E., and Engel, von A., *Phys. Rev.*, 93, 1121 (1954).

Optical Aspherizing by Vacuum Evaporation

J. Strong and E. Gaviola¹ described the preparation of optical aspherics by vacuum evaporation. They used layers of aluminium to parabolize mirrors, but found that with thickness greater than 5λ the coating began to show a bloom and scatter light. Apparatus for the production of refracting elements by this method was described by L. G. Schulz²; Schulz used lithium fluoride and was able to produce aspheric films giving a retardation $[(n-1)t]$ of up to 2.5λ . At that thickness the films began to peel off. The retardation could be doubled by covering the lithium fluoride film with a layer of collodion and evaporating on to this another layer of lithium fluoride.

We have now prepared zinc sulphide films giving retardations up to $30-40\lambda$ mercury green light, the upper limit of thickness not having yet been reached. The films did not show any signs of weathering or instability over periods of one to two months. Longer-term experiments are in progress. There was also no change in optical thickness.

Using ordinary quality zinc sulphide containing appreciable impurities (including more than 1 per cent silicon), the films are yellowish when viewed by transmission; but a layer giving about 30λ retardation would transmit about 85 per cent of the light in the $5000-7000 \text{ \AA}$. region incident upon it, allowing for surface reflexion losses. Films made from a much purer sample of zinc sulphide are less coloured. This material is being investigated further.

The reflexion losses at the zinc sulphide-air and zinc sulphide-glass interfaces are considerable, but they can be reduced by using anti-reflexion coatings. Two-layer coatings for each interface were computed using zinc sulphide and magnesium fluoride, and were found to work well in practice.

The present apparatus is similar in principle to that of Schulz. The distance between the boat and the plate or lens on to which the film is evaporated is about 11 in. Glass plates of diameters up to 4 in. can be accommodated at present. The boat can be recharged several times, so that a film of retardation up to 10λ can be deposited without breaking the vacuum.

The films produced show very good revolution symmetry. In a typical case, at a point of 25λ retardation which lay on a circle of diameter 8 cm. , the eccentricity was 0.05λ retardation. The direc-

tional dependence of the rate of evaporation of the source was found to be reproducible to 1 part in 1,000.

The first attempt at cutting a template to give a certain aspherization yielded a film in which the maximum departure from the desired retardation was 0.3λ. The maximum retardation of this film was 6λ. This error, which depends a lot on the type of aspherizing required, could be eliminated by suitable adjustments of the template shape. It was found that if the template was removed and then replaced again, the resultant aspherizing could vary by 5 parts in 1,000. This could be remedied by a better mounting arrangement for the template.

It is hoped to publish a more detailed description of this work elsewhere.

J. A. DOBROWOLSKI
W. WEINSTEIN

Technical Optics Section,
Imperial College of Science and Technology,
London, S.W.7.

Oct. 11.

¹ *J. Opt. Soc. Amer.*, **28**, 153 (1936).

² *J. Opt. Soc. Amer.*, **38**, 432 (1948).

The Yellow Emission Line of the Solar Corona

In 1942, Edlén¹ identified twenty-three emission lines in the solar corona. One of the two doubtful identifications in the list, that of the yellow line λ 5694 with the transition $2p^2 \ ^3P_1 \rightarrow 0$ in Ca XV, presents an especially interesting problem, because the ionization energy of Ca XV (814 eV.) exceeds that of every ion known to produce coronal lines. If Edlén's identification were to prove correct, it would provide an important clue to the mystery of coronal excitation.

In 1947, Waldmeier² discovered a companion line at λ 5445, which he later³ attributed to the transition $2p^2 \ ^3P_{2-1}$ in Ca XV. Edlén had pointed out earlier⁴ that a companion line ought to appear in the visible spectrum, and its discovery supported his original identification.

Shklovsky⁵ showed, however, that the intensity ratio measured by Waldmeier, $I(5694)/I(5445) = 6$, could not be explained by any known mechanism for exciting the levels in Ca XV. A thorough semi-theoretical analysis by Garstang⁶ of the ground configuration in the long isoelectronic sequence headed by Cl I cast further doubt on the identifications. Garstang's predicted wave-lengths, 5380 Å. for the transition $2 \rightarrow 1$ and 5480 Å. for the transition $1 \rightarrow 0$, did not differ greatly from the observed wave-lengths; but the internal consistency of the analysis seemed to exclude an error of more than 50 Å. in either of the predicted wave-lengths.

Recently, two new pieces of evidence have come to light. From measurements of line-widths, Mme. Pecker, Billings and Roberts⁷ derived an atomic weight of 40 ± 2 for the ion producing the yellow line. They also discovered that Waldmeier's line, λ 5445, is blended with a Fraunhofer (absorption) line. By correcting for this effect, they were able to reduce the intensity ratio from 6 to 1.6, which is in satisfactory agreement with Shklovsky's theory.

Although the results obtained by Mme. Pecker, Billings and Roberts do not actually contradict Garstang's conclusion, they do raise the question whether the small discrepancies between the predicted and the observed wave-lengths may not be due to some imperfection in the underlying theory.

I have recently completed a calculation which suggests that in fact they are.

The chief defect of the theory used by Garstang is its approximate treatment of configuration mixing. The theory takes account of some of the effects of configuration mixing, but neglects others which are significant when the spin-dependent interactions compete seriously with the electrostatic interactions, as in Ca XV. For example, consider the electrostatic coupling between the levels of two ^3P terms, the upper one inverted, as in the accompanying diagram. Configuration mixing depresses the unperturbed levels of the lower term. On the approximate theory used by Garstang, the three displacements are equal. Consequently, the spacing of the perturbed levels is the same as the spacing of the unperturbed levels. In reality, the three displacements are unequal, being inversely proportional (roughly) to the intervals between corresponding unperturbed levels in the two terms.

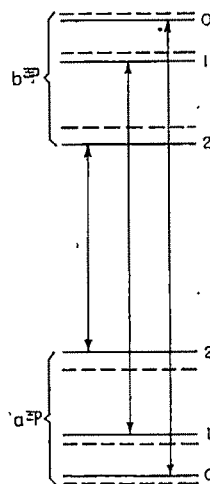


Fig. 1. Levels of two coupled ^3P terms, the upper one inverted. The solid horizontal lines are the unperturbed levels. Levels connected by the vertical lines repel each other; the displacements being roughly proportional to the reciprocals of the intervals between corresponding levels in the two terms. The broken lines are the perturbed levels.

A theoretical argument shows that in Ca XV the ground configuration ($1s^2$ ($2s^2$) ($2p^2$)) interacts weakly with all the higher-lying configurations except ($1s^2$) ($2p^4$). We may therefore identify the energy-levels of the ground configuration with the smallest five eigen-values of a tenth-order matrix the elements of which connect the levels of ($1s^2$) ($2s^2$) ($2p^2$) and ($1s^2$) ($2p^4$). This matrix, which reduces to a pair of fourth-order matrices and a second-order matrix, involves nine undetermined parameters. One of these is a trivial additive constant to the energy-levels; three can be eliminated by a simple theoretical argument; and I have evaluated two more by extrapolation along the isoelectronic sequence. In addition, I have taken over all Garstang's extrapolated parameters, and these complete the list. Thus the present calculation differs from Garstang's only in the underlying theory, and not in the choice of parameters.

The results of the calculation are: $E(^3P_1) - E(^3P_0) = 5650$ Å., as compared with 5694 Å. for the yellow line; and $E(^3P_2) - E(^3P_1) = 5456$ Å., as compared with 5445 Å. for Waldmeier's line. In view of the approximate character of the calculations, the agreement is satisfactory, and tends to confirm the identifications of Edlén and Waldmeier.

A detailed account of this work will appear in the *Monthly Notices of the Royal Astronomical Society*.

DAVID LAYZER

Harvard College Observatory,
Cambridge, Mass.
Nov. 29.

¹ Edlén, B., *Z. Astrophys.*, 22, 30 (1942).

² Waldmeier, M., *Astro. Mitt. Zurich*, No. 151 (1947).

³ Waldmeier, M., *Z. Astrophys.*, 29, 29 (1951).

⁴ Edlén, B., *Physica*, 12, 738 (1946); *Nature*, 157, 297 (1946).

⁵ Shklovsky, I., *Ann. Crimean Astrophys. Obs.*, 5, 86 (1950).

⁶ Garstang, R. H., *Astrophys. J.*, 115, 569 (1952); *Mon. Not. Roy. Astro. Soc.*, 111, 116 (1951).

⁷ Pecker, Charlotte, Billings, D., and Roberts, W. O., *C.R. Acad. Sci., Paris*, 238, 1101 (1954).

Conductivity induced in Mica by X-Rays

ALTHOUGH mica is not recognized as one of the highly insulating materials (its specific volume conductivity is quoted in standard reference books as between 10^{-14} and 10^{-17} ohm-cm.⁻¹ at 20° C.), its behaviour under X-irradiation is of interest in comparison with the organic plastic insulating materials which we have studied¹.

The experiments on mica were made with sheets 0.15 mm. thick, using the d.c. amplifier technique which we have previously described¹. Mica shows relatively low values of induced conductivity, of the same order as those in polymethyl methacrylate and amber. The conductivity in mica is not greatly dependent on temperature, and in this respect also it is similar to 'Perspex' and amber. The equilibrium induced conductivity is almost linear with dose-rate, and the recovery after irradiation is rapid. These characteristics lead us to place mica in Class 1 of the insulators we have studied², together with plasticized 'Perspex' and amber. (Class 2 includes polystyrene, polytetrafluoroethylene, and unplasticized 'Perspex'.)

Dose-rate dependence. In the relationship between equilibrium induced current i_x and dose-rate R ,

$$i_x \propto R^\Delta, \quad (1)$$

we find $\Delta = 0.95 \pm 0.05$ for mica over the range $R = 2-64$ r./min. and between -20° and 100° C. This value does not exclude the possibility of Δ being exactly 1; but it is likely that several of the materials generally believed to have $\Delta = 1$ do in fact have values of Δ slightly less than unity; recent measurements have indeed shown this to be so for red 'Perspex'. Physically, this deviation from unity means that the distribution of traps in depth (energy) is correspondingly non-uniform, with a greater number of shallow traps³. Accurate values of Δ are difficult to determine for mica, due to the large static conductivity. There is no doubt, however, that mica is among those materials with Δ closest to unity, and therefore on the basis of an electron-trapping model⁴ the distribution of traps is likely to be comparatively uniform.

Dependence on temperature. Fig. 1 shows the graphs of log (conductivity) of mica plotted against the reciprocal of absolute temperature. The resulting straight lines are of slope proportional to the activation energy, according to the general formula,

$$\sigma = \sigma_0 \exp(-W/kT). \quad (2)$$

In the case of static conductivity (that is, with no incident radiation), $W = 0.45$ eV. This is a considerably lower value than those obtained for the

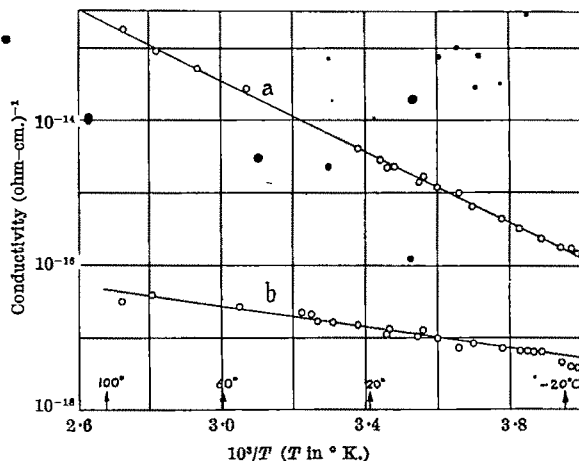


Fig. 1

plastic insulators studied (1.1-1.5 eV.), and to some extent correlates with the relatively high static conductivity of the mica.

For the equilibrium induced conductivity (Fig. 1b) at $R = 7$ r./min., the slope corresponds to $W = 0.18$ eV. The current therefore increases by a factor of about 10 between 0° and 100° C. If we assume a slightly non-uniform distribution of traps corresponding to $\Delta = 0.95$, the theoretical increase is by a factor of 30. (If $\Delta = 1$, the increase would be very small indeed.) The agreement with this model is reasonable.

Since the induced current in mica is seen as a small increase above the 'dark current', accurate measurement was achieved at the low dose-rates only by cooling the vacuum chamber and the sample to about -20° C. by means of solid carbon dioxide. The dark current was thereby reduced by a much greater factor than the induced current, and the value of i_x could be determined.

Decay of induced current. The induced current falls rapidly at the end of irradiation to less than one-tenth of the equilibrium value. We were not able to determine whether there was any subsequent longer-term decay of residual current, as the recovery appeared to be complete within a few seconds.

Comparison with other results. Coleman (private communication, 1954) has reported a value of Δ equal to 1, and the actual values of induced conductivity measured by him⁴ accord well with those given above. He finds an activation energy of zero for induced conductivity, which is in general accordance with our low value. The cause of this difference may lie in different degrees of impurity in the mica; but it is probably significant that the values of activation energy of insulators measured by different observers, or by the same observers on different samples of a given material, are not in such good agreement as are the values of Δ .

J. F. FOWLER
F. T. FARMER

Radiotherapy Department,
Royal Victoria Infirmary,
Newcastle upon Tyne 1.
Jan. 4.

¹ Fowler, J. F., and Farmer, F. T., *Nature*, 171, 1020 (1953); 173, 317 (1954).

² Fowler, J. F., and Farmer, F. T., *Nature*, [175, 516 (1955)].

³ Rose, A., *R.O.A. Rev.*, 12, 362 (1951).

⁴ *Proc. U.S. Nat. Acad. Sci.* (in the press)

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Tuesday, April 12

INSTITUTE OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 6.30 p.m.—Annual General Meeting*

Wednesday, April 13

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. W. Platt: "The Oil Industry—Its Place in the World and Its Future".*

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Discussion meeting on "The B.B.C. V.H.F. F.M. Sound Broadcasting Service".

Thursday, April 14

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Science Museum Lecture Theatre, Exhibition Road, London, S.W.7), at 4.30 p.m.—Dr. L. C. Jackson and Dr. E. Mendoza: "Problems in the Storage and Transport of Liquid Hydrogen and Helium".

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. C. H. Gibbs-Smith: "Classification and Storage of Pictorial Material".

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6 p.m.—Annual General Meeting, followed by a Discussion on "Recent Developments in Special Machining Techniques".

Thursday, April 14—Friday, April 15

INSTITUTE OF PHYSICS, EDUCATION GROUP (at 47 Belgrave Square, London, S.W.1), at 10 a.m. daily—Annual Conference.

Thursday, April 14—Sunday, April 17

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at Folkestone)—Sixtieth Annual Congress.

Thursday, April 14—Monday, April 18

BRITISH PSYCHOLOGICAL SOCIETY (at the University, Durham).—Annual Conference.

Saturday, April 16

At 9.30 a.m.—Annual General Meeting.

Friday, April 15

INSTITUTE OF METALS, OXFORD LOCAL SECTION (in collaboration with the METAL PHYSICS COMMITTEE, in the Lecture Theatre of thearendon Laboratory, Parks Road, Oxford), at 11 a.m.—Informal Discussion on "Fatigue"; 2.30 p.m.—Brain's Trust Session.*

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—Commander E. M. Penton, D.S.C., R.N.: "A Voyage Through the North-West Passage".

INSTITUTE OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. J. S. Halliday: "Surface Examination by Reflection Electron Microscopy".

Friday, April 15—Saturday, April 16

BIOCHEMICAL SOCIETY (joint meeting with the ASSOCIATION OF CLINICAL BIOCHEMISTS, in the Department of Biochemistry, The University, Liverpool), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

DEPARTMENTAL LECTURER (with special qualifications in mathematics and experience of school-teaching) in the UNIVERSITY DEPARTMENT OF EDUCATION—The Secretary of the University Department of Education, 17 Brookside, Cambridge (April 15).

LECTURER in the DEPARTMENT OF BACTERIOLOGY—The Registrar, The University, Liverpool (April 15).

LECTURER or SENIOR LECTURER in MATHEMATICS, and LECTURERS or SENIOR LECTURERS (2) in PHYSICS and MECHANICS, at Britannia N. College, Dartmouth—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4443/55 (April 15).

ASSISTANTS in MATHEMATICS—Secretary of University Court, The University, Glasgow (April 16).

LECTURER (with a university degree in pharmacology, or a degree in physiology or pharmacy, with additional special training in pharmacology) in PHYSIOLOGY and PHARMACOLOGY—The Clerk and Treasurer, Dundee Technical College, 40 Bell Street, Dundee (April 16).

SENIOR ASSISTANT PHYSICIST (with an honours degree in physics and previous experience in hospital physics) in the RADIO-THERAPY and X-RAY DIAGNOSTIC DEPARTMENTS—The Personnel Officer, St. Thomas's Hospital, London, S.E.1 (April 18).

UNIVERSITY LECTURER in the DEPARTMENT OF GEOLOGY—Appointments Committee of the Faculty of Geography and Geology, Department of Geography, Cambridge (April 18).

RIVER INSPECTOR (with a university degree in chemistry, and member of the Institute of Sewage Purification), within the area of the North River Purification Board—The Clerk to the Board, Forth River Purification Board, County Offices, Viewforth, Stirling (April 20).

TECHNICAL ASSISTANT (female) (preferably with experience of radioactive techniques), to assist in clinical and experimental research work and treatments using radioactive isotopes—The Secretary, Mount Vernon Hospital, Northwood, Middlesex (April 22).

CHAIR OF INORGANIC CHEMISTRY, tenable at the Imperial College of Science and Technology, London, S.W.7—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 28).

ASSISTANT LECTURER in BACTERIOLOGY, and an ASSISTANT LECTURER in MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (April 30).

ASSISTANT LECTURER (with special qualifications in organic chemistry) in CHEMISTRY—The Registrar, The University, Manchester 13 (April 30).

ASSISTANT LECTURER (with a good honours degree, and preferably with a knowledge of Greek and German) in PHILOSOPHY—The Registrar, King's College, Strand, London, W.C.2 (April 30).

CHAIR OF MECHANICAL ENGINEERING—The Registrar, The University, Sheffield 10 (April 30).

CHAIR OF PHYSICAL METALLURGY—The Registrar, University College, Singleton Park, Swansea (April 30).

LECTURER in ORGANIC CHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 30).

LECTURER (with a good honours degree in biochemistry or organic chemistry (natural products)) in BIOCHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (May 9).

TECHNICAL OFFICER (paint chemist) (with at least a recognized B.Sc. degree in chemistry or physics or an equivalent qualification and a thorough knowledge of paint raw materials, paints and the testing and manufacture of paint), for duties which include the preparation of specifications and the testing of paints and paint materials—The Secretary, South African Bureau of Standards, Private Bag, 191, Pretoria, South Africa (June 16).

AGRICULTURAL OFFICER (Tobacco) (with a university degree in agriculture or a related subject, and a knowledge of field experimentation, and practical experience of the cultivation of tobacco, including flue-cured tobacco) in H.M. Overseas Civil Service, Uganda, to make a survey of tobacco potentialities in Uganda, and to be in charge of all investigational work on this crop—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/9/CI.

CHAIR OF PHYSICS, and CHAIR OF GENERAL CHEMISTRY, at the Royal College of Medicine, Baghdad, Iraq—The Director, Personnel Department, The British Council, 65 Davies Street, London, W.1.

EXPERIMENTAL OFFICER (with at least higher school certificate in science subjects or general certificate of education 'advanced' in two science subjects or equivalent qualifications, or preferably with higher qualifications in metallurgy, physics or chemistry), to do fundamental research and development work on the metallurgy of plutonium—The Establishment Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/260.

FISHERIES OFFICER (with a university degree in a natural science and an interest in natural history) in the Gold Coast Local Civil Service, to assist in the development of marine and freshwater fisheries, and to investigate scientific and technical problems relating to the fishing industry—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.65/13/01.

GRADUATE PHYSICIST or FUEL TECHNOLOGIST (with ability to apply mathematics to problems of open hearth furnace operation), in the laboratories of the Steelmaking Division, British Iron and Steel Research Association, Sheffield—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Steelmaking".

HEAD OF THE DEPARTMENT OF CHEMISTRY (including colour chemistry and dyeing)—The Principal, Technical College, Queen Street South, Huddersfield.

LECTURERS (with a degree or H.N.C. in electrical engineering or physics, and preferably with teaching experience, and a knowledge of R.F. fundamentals and transmission pulse technique, optics, audio frequency engineering or acoustics), in the B.B.C. Engineering Training Department, Evesham, to train staff varying from operator to graduate—Engineering Establishment Officer, Broadcasting House, London, W.1, quoting BX.28N.

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemical engineering, and experience of research in that field, or in chemistry, and post-graduate experience either as a physical chemist in the chemical engineering field or as a research chemical engineer), to lead a team concerned with developing special equipment from fundamental studies of a physico-chemical nature, including hydrodynamical and fluid pumping problems, electrochemistry of solutions, chemical kinetics and phase equilibria—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 561/WGE/34.

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry or chemical engineering, and many years' experience, preferably of work in the fields of casting, pelleting of powders, sintering or slurry pouring), to lead a section consisting of Chemists and Chemical Engineers carrying out development work in a new field of inorganic materials technology, the aim of which is to find the best means of making components from reactive chemicals (Ref. 572/WGE/34); and a SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemical engineering or Corporate Member of the Institution of Chemical Engineers, or equivalent qualifications, and several years' research or development experience in chemical engineering) to be responsible for the initial design of a special prototype plant for manufacture of an organic chemical, and development into works scale production units (Ref. 572/WGE/34)—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting appropriate Ref. No.

PROFESSOR and an ASSISTANT PROFESSOR or SENIOR LECTURER specializing in taxonomy or ecology—The Dean, College of Arts and Sciences, Baghdad, Iraq.

SCIENTIFIC ASSISTANT (with a knowledge of at least two European languages and training or experience in agricultural (especially soil) sciences), for work involving abstracting and indexing.—The Director, Rothamsted Experimental Station, Harpenden, Herts.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in chemistry or chemical engineering) for (a) to study compatibility of liquid metals with reactive chemical compounds at high temperatures, and materials of construction for chemical plant, and to study protective coatings for such reactive compounds; (b) to study rheological properties of slurries, high temperature metals, etc., and the relationship between the properties and chemical and physical constitution; and (c) to carry out work concerned with the manufacture of large components from reactive chemicals by such techniques as pressing, casting, pouring, etc.—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 574/WGE/34.

SENIOR EXPERIMENTAL OFFICER (preferably with a pass degree in chemical engineering or at least H.S.C. in science subjects) to lead and organize important experimental work on laboratory and pilot scale equipment in the chemical engineering laboratory and ultimately to take charge of a prototype process unit (Ref. 558/WGE/34); and a SENIOR EXPERIMENTAL OFFICER (preferably with a pass degree in physics, or at least H.S.C. in science subjects) to be responsible for the organization and supervision of a small research and development group handling large quantities of highly radioactive materials (Ref. 562/WGE/34)—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting appropriate Ref. No.

SENIOR LECTURER IN MECHANICAL ENGINEERING at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

- The Engineer Buyers Guide*, 1955. Pp. 745. (London: *The Engineer*, 1955.) 5s. [211]
- Association of British Pharmaceutical Industry: a Record of its History and Progress, 1930-1955. Issued on the occasion of the 25th Anniversary of the Association, January 1955. Pp. 32. (London: The Association of British Pharmaceutical Industry, 1955.) [211]
- Abstracts of papers which have appeared in the *Journal of the British Institution of Radio Engineers* over the past 15 years. Pp. 48. (London: British Institution of Radio Engineers, 1955.) 2s. [211]
- General Register Office. The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates. Quarter ended 30th September, 1954. (No. 423.) Pp. 27. (London: H.M. Stationery Office, 1955.) 2s. net. [211]
- Bulletin of the British Museum (Natural History). Geology. Vol. 2, No. 6: Further Contributions to the Solution of the Pitdown Problem. By J. S. Weiner, W. E. Le Gros Clark, K. P. Oakley, G. F. Claringbull, M. H. Hay, F. H. Edmunds, S. H. U. Bowie, C. F. Davidson, C. F. M. Fryd, A. D. Baynes-Cope, A. E. A. Werner and R. J. Plesters. Pp. 225-287 + plates 27-31. (London: British Museum (Natural History), 1955.) 20s. [211]
- Imperial College of Science and Technology. Forty-Seventh Annual Report of the Governing Body, 1953-1954. Pp. 65. (London: Imperial College of Science and Technology, 1955.) [211]
- Aluminium Alloy Sections for Marine Use. (Addendum to Information Bulletin No. 18.) Pp. 12. (London: Aluminium Development Association, 1954.) [211]
- Sonic and Ultrasonic Methods for Testing Engineering Materials (with particular reference to Concrete). Pp. 12. (Southall, Mdx.: A. E. Cawkell, 1955.) [211]
- Oxford's Contribution to the Origins of Modern Science. By A. C. Crombie. (A paper read to the British Association for the Advancement of Science at Oxford on 6 September 1954.) Pp. 27. (Oxford: Basil Blackwell, 1954.) 2s. 6d. net. [211]
- Journal of the Institution of Electrical Engineers. Vol. 1, No. 1 (January 1955). New Series. Pp. xx+64. Published monthly. (London: Institution of Electrical Engineers, 1955.) 5s. [211]
- National Institute of Oceanography. Collected Reprints. Vol. 2: Nos. 62-95. (Wormley. National Institute of Oceanography, 1954.) [211]
- Journal of the West African Science Association. Vol. 1, No. 1 (October, 1954). Pp. 72+1 plate. (London: Charles Knight and Co., Ltd., 1954. Published for the West African Science Association.) [211]
- Professional Training in the G.E.C. Pp. 28. (London: General Electric Co., Ltd., 1955.) [211]
- Annual Report of the National Oceanographic Council, 1 April 1953-31 March 1954. Pp. v+28. (Cambridge: At the University Press, 1955.) 5s. net. [211]
- Year Book of the Textile Institute. No. 7: 1954-55. Pp. xvii+248. (Manchester: Textile Institute, 1955.) 15s. [211]
- John Innes Leaflet No. 13: The John Innes High Rate Soil Sterilizer. Pp. 10. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 1s. net. [211]
- Irish Republic. Department of Agriculture: Fisheries Branch. Report on the Sea and Inland Fisheries for the year 1953, incorporating Statistics of the Capture of Salmon, Sea Trout and Eels. Pp. 60. (Pr. 2429.) (Dublin: Stationery Office.) 2s. 6d. [211]
- Proceedings of the University of Durham Philosophical Society. Vol. 12, No. 1: A Preliminary Account of the Geological Structure of North Northumberland and the Borders. By Dr. D. A. Robson. Pp. 9. Vol. 12, No. 2: The West Sleekburn Thorolite which Contains a Large Cavity. By B. A. O. Randall. Pp. 10-13. Vol. 12, No. 3: The Shape and Nature of the Pre-Glacial Wear Valley between Coken and Chester-le-Street, County Durham. By D. H. Maling. Pp. 14-28. (Durham: University of Durham Philosophical Society, 1954.) [271]

Other Countries

- Annals of the New York Academy of Sciences. Vol. 60, Art. 1: Speciation and Variation in Asexual Fungi. By Kenneth B. Raper and 22 other Authors. Pp. 182. Vol. 60, Art. 2: 6-Mercaptopurine. By George W. Hitchings and 84 other Authors. Pp. 183-608. 4.50 dollars. (New York: New York Academy of Sciences, 1954.) [211]
- The Commonwealth Fund. Thirty-sixth Annual Report for the year ending June 30, 1954. Pp. ix+42. (New York: Commonwealth Fund, 1954.) [211]
- Pubblicazioni della Università Degli Studi di Firenze—Facoltà di Scienze Matematiche, Fisiche e Naturali. Fascicolo Nr. 69: Osservazioni e Memorie dell'Osservatorio Astronomico di Arcetri. Pp. xv+164. (Firenze: Università di Firenze, 1954.) [211]
- Berichte des Deutschen Wetterdienstes. Nr. 14: Charakteristikenverfahren in der numerischen Wettervorhersage. Von Karl Hinkelmann und Rudolf Schwarzenberger. Pp. 26. (Bad Kissingen: Deutscher Wetterdienstes, 1954.) [211]
- Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Carte des Sols et de la Végétation du Congo Belge et du Ruanda-Urundi. 4:—Nioka (Ituri). A. B et C. Notice Explicative de la Carte des Sols et de la Végétation. Par N. Holowaychuk, I. Denissioff, P. Gilson, J. Groegaert, L. Liben et T. Sperry. Pp. 81. D: Geomorphologie. Geology of the Sols of the Nioka-Ituri Area, Belgian Congo. By Robert V. Ruhe. Pp. 27. (Bruxelles: l'Institut National pour l'Étude Agronomique du Congo Belge, 1954.) [211]
- University of Illinois. Engineering Experiment Station Bulletin No. 424: The Distribution of Concentrated Loads by Laminated Timber Slabs. By Prof. Whitney C. Huntington, Prof. William A. Oliver, Melvin W. Jackson and William T. Cox. Pp. 69. 1 dollar. No. 425: Effect of Body Feed on the Filtration of Water through Diatomite. By Prof. Harold E. Babbitt and E. Robert Baumann. Pp. 40. 0.80 dollar. No. 426: Inelastic Behavior of Ductile Member Under Dead Loading. By Prof. M. E. Clark, Prof. H. T. Corten and Prof. O. M. Sidebottom. Pp. 48. 1 dollar. No. 427: Outdoor-Air Supply and Ventilation of Furnace Closet Used with a Warm-Air Heating System. By Prof. Robert W. Roose, Norman A. Buckley and Prof. Seichi Konzo. Pp. 50. 1.70 dollars. (Urbana, Ill.: University of Illinois, 1954.) [211]
- State of Illinois: Department of Registration and Education. Division of the State Geological Survey. Report of Investigation No. 176: Use of the Refraction Seismic Method for Differentiation Pleistocene Deposits in the Arcola and Tuscola Quadrangles, Illinois. By Robert B. Johnson. Pp. 60. (Urbana, Ill.: State of Illinois, Department of Registration and Education, 1954.) [211]
- Abridged Scientific Publications from the Kodak Research Laboratories. Vol. 32: 1950. Pp. 320+ xv. (Rochester, N.Y.: Eastman Kodak Company, 1954.) [211]
- Deutsche Akademie der Wissenschaften zu Berlin. Institut für Physikalische Hydrographie. Acta Hydrophysica. Herausgegeben von H. Ertel und J. Fischer. Band 2, Heft 1: Über eine "nicht nomographierbare" Funktion. Von Joh. Fischer. Beiträge zum Problem brandender Wellen. Von Kurt Vollbrecht. Pp. 30. Band 2, Heft 2: Über die Reflexion der diffusen Himmelsstrahlung an eine unbewegten Wasseroberfläche. Von H. Grisesier. Zur Frage der Sedimentbewegung im litoralen Gürtel. Von K. Vollbrecht. Pp. 31-80. (Berlin: Akademie-Verlag, 1954.) [211]
- Falkland Islands and Dependencies. Meteorological Service. The Meteorology of the Falkland Islands and Dependencies, 1944-1950. By Dr. J. Pepper. Pp. vi+249 (15 plates). Stanley, Falkland Islands: Meteorological Service; London: Crown Agents for Overseas Governments and Administrations, 1954.) 42s. [211]
- Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Technique No. 43: Caractères généraux des boues feuillues du Congo Belge en relation avec leur utilisation dans l'industrie des pâtes à papier—Étude détaillée de quelques essences. Par J. F. Istas, R. Heremans et E. L. Raekelboom. Pp. 122. 80 francs. Série Scientifique No. 62: L'Accumulation des sesquioxides libres dans les sols tropicaux. Par Dr. J. D'Hooze. Pp. 132. 80 francs. Série Scientifique No. 63: Une classification écologique des forêts du Congo. Par J. Lebrun et G. Gilbert. Pp. 90+8 plates. 60 francs. Bureaux Climatologiques. Communication No. 9: Saisons et Périodes Sèches et Pluvieuses au Congo Belge et au Ruanda-Urundi. Par Dr. J. Buitot. Pp. 70+7 maps. (Bruxelles: l'Institut National pour l'Étude Agronomique du Congo Belge, 1954.) [211]
- University of Adelaide—School of Geology. Publication No. 239: Stratigraphy and Structure of the Northern Territory of Australia. By Paul S. Hossfeld. Pp. 58+3 plates. (Adelaide: The University, 1954.) [211]
- Rendiconti Istituto Superiore di Sanità. Volume 17. English edition. Pp. x+243+46 plates. (Roma: Fondazione Emanuel Paterno; Oxford: Blackwell Scientific Publications, Ltd., 1954) 5000 lire; 57s. 8d. [211]
- Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 112, No. 5: The Comparative Biology of Reproduction in the Wood-boring Isopod Crustacean *Limnoria*. By Robert J. Menzie. Pp. li+383-388. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [211]
- Museum of Comparative Zoology at Harvard College. Breviora. No. 38 (November 28, 1954): *Ornia* (Trilobita) from Venezuela. By H. J. Whitington. Pp. 7 (1 plate). No. 39 (November 24, 1954): New or Redescribed Pelomedusid Skulls from the Tertiary of Africa and Asia (Testudines, Pelomedusidae). 2: A Podocnemid Skull from the Miocene of Moghara, Egypt. By Ernest Williams. Pp. 8+ plates. No. 40 (November 29, 1954): Some Mollusks from the Continental Slope of Northeastern North America. By Arthur I. Clarke, Jr. Pp. 11. No. 41 (December 17, 1954): Comments on the Classification of Rodents. By Albert E. Wood. Pp. 9. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [211]
- U.S. Department of Commerce: Weather Bureau. Technical Paper No. 28: Floods of 1952—Upper Mississippi—Missouri—Red River—the North. Prepared by the Hydrologic Services Division. Pp. vi+93 (12 plates). (Washington, D.C.: Government Printing Office, 1954.) 1 dollar. [211]

NATURE

No. 4459

SATURDAY, APRIL 16, 1955

Vol. 175

CONTENTS

	Page
Science and Defence	651
Biology and Radiation. By R. H. Mole, T. C. Carter and Dr. J. F. Loutit	653
Progress In Physics. By S. Weintraub	653
A City Naturalist's Musings. By R. S. R. Fitter	654
Home-life of the Atlantic Seal. By Seton Gordon, C.B.E.	655
Crystallographic Structure Reports. By Dr. H. J. Grenville-Wells	655
Electronics in the Physiological Laboratory. By Dr. B. C. Abbott	656
Two Geological Centenaries : G. B. Greenough, F.R.S. (1778-1855), and Sir Henry de la Beche, F.R.S. (1796-1855). By V. A. Eyles and J. M. Eyles	658
Sir John Bland-Sutton, Bart. (1855-1936). By W. R. Bett	660
The Properties of Solid Argon. By Prof. C. Domb	661
Obituaries :	
Sir Alexander Fleming, F.R.S. By Prof. Robert Cruickshank	663
Prof. A. L. Dixon, F.R.S. By Dr. W. L. Ferrar	663
News and Views	664
Research in Technical Colleges. By Dr. F. Happey	669
Smithsonian Institution : Annual Report for 1953-54	670
Viscosity of Polymer Solutions	670
The Council for the Promotion of Field Studies	671
Nebulae and Star Clusters	671
Japanese Forestry Research. By Prof. E. P. Stebbing	672
Effect of Implantation Site on the Development of an Implant in the Chick Embryo. By Dr. John W. Saunders, jun., Mary T. Gasseling and Dr. John M. Cairns	673
A General Creep and Recovery Property of Metals. By Dr. A. J. Kennedy	674
Inhibition by Simple Sugars of Enzymes which decompose the Blood-Group Substances. By Dr. Winifred M. Watkins and Prof. W. T. J. Morgan, F.R.S.	676
Letters to the Editors :	
Indication of a Magnetic Field of the Planet Venus.—Dr. J. Houtgast	674
Photographic Preparation of Masks of Large Molecules for the Lipson Diffractometer.—C. W. Hooper, Dr. W. E. Seeds and Dr. A. R. Stokes	679
Doppler Spectrum of Sea Echo at 13.56 Mc./s.—D. D. Crombie	681
Effects of Temperature and High-speed Sliding on the Friction of 'Teflon' on 'Teflon'.—D. G. Flom and N. T. Porlie	682
Rotations, Orientations and Collisions of Suspended Particles in Velocity Gradients.—R. St. J. Manley, A. P. Arlov and S. G. Mason	682
The Origin of Man.—Prof. E. Orowan, F.R.S.	673
Variation in the Amounts of Deoxyribonucleic Acid in the Cell Nuclei and its Correlation with Mitotic Activity : Compensatory Hypertrophy of the Kidney.—Prof. J. Fautrez, G. Cavalli and E. Pisi	684
Synthesis of Peptides by Aminolysis of Nitrophenyl Esters.—Dr. M. Bodánszky	685
Identification of the Protein Fraction of Human Serum containing the Thyrotropic Hormone.—L. D. F. Laméijer, A. A. H. Kassenaar and Prof. A. Querido	685
Adsorption as a Major Phenomenon in the Concentration of Gonadotrophins by Ultrafiltration.—Dr. Henriette A. van Gilse	686
Gonadotrophic Action of Corticosteroids in <i>Xenopus laevis</i> and its Isolated Ovary.—A. C. J. Burgers and Prof. H. Zwarenstein	687
Grafting and Hybridization Experiments in the Genus <i>Trifolium</i> .—Alice M. Evans and Thore Denward	687
Shikmic Acid as a Precursor in Lignin Biosynthesis.—Stewart A. Brown and A. C. Neish	688
Internal Seed Disinfection by an Antibiotic from <i>Streptomyces rimosus</i> .—J. Dekker	689
A Marine Bacteriophage.—R. Spencer	690
Enzymatic Production of Carbon Dioxide in <i>Hevea</i> Latex.—Dr. F. J. Paton and H. M. Collier	691
The Protein from <i>Balanites aegyptica</i> .—W. E. F. Naismith	692
Rabbit Fleas on Wild Rabbits and the Transmission of Myxomatosis.—R. M. Allan and P. L. Shanks	692

HYDRAULIC OPERATION AND CONTROL OF MACHINES

IAN McNEIL, M.A.(Cantab.), A.I.Mech.E.

"The author has bridged a gap between the information given by textbooks which deal with pure theory, and the practical application of this theory. The book deals very thoroughly with all aspects of Hydraulic Power . . . and should prove of the utmost use to both students of Hydraulic Engineering and practising Engineers."

Review in *Technical Journal*

336 pages

140 illustrations

35s. net

CHEMICAL PROCESSING OF WOOD

A. J. STAMM, Ph.D.

E. E. HARRIS, Ph.D.

"The emphasis is on the new processing methods which have not been formerly dealt with in book form. It would be difficult to recommend a book in which scrupulousness and balance in approach are more evident."

Review in *Wood*

605 pages

35 Illustrations, 90 Tables

63s. net

THAMES AND HUDSON

244 High Holborn London W.C.1

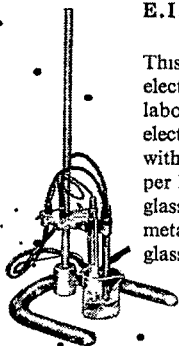


portable pH meter

This is an entirely portable battery operating unit, accurate to 0.1 pH. It is fully equipped for speedy pH determination in situ, yet its dimensions are confined to the practical minimum. Model 30 is ideal for research work on location.

E.I.L. pH ELECTRODES

This range extends from micro-electrodes for the analysis of small laboratory samples, to industrial electrode systems capable of dealing with flows of several hundred gallons per hour. In addition to new types of glass and reference electrodes, a range of metal electrodes is available for use where glass electrodes are unsuitable.



You are invited to send for a cost free copy of the informative, extensively illustrated E.I.L. catalogue.

Electronic Instruments Limited

RICHMOND SURREY ENGLAND

RICHMOND 5656

SCIENCE AND DEFENCE

ALREADY in the Statement on Defence last year the Government expressed its concern at the mounting cost of unconventional weapons of war as the process of development continues, at the tactical and strategic problems presented by these new weapons, and at the necessity of holding a careful balance between the demands of defence and those of other sectors of the economy. Such considerations have lost none of their force in the meantime, and although the gross total expenditure on defence of £1,813 million and of £837 million on production and research are relatively unchanged from last year's figures of £1,864 million and £867 million, respectively, it is clear from the recent Statement on Defence, 1955* that science occupies a key position in the defence policy of Britain. Finance apart, that follows from the Government's acceptance of deterrence as the keystone of its new defence policy. The hesitations of last year have been cast aside, and the argument of the White Paper and the new order of priorities which it lays down start from the acceptance of the hydrogen bomb.

Overshadowing all else in 1954, the reasoning runs, has been the emergence of the thermonuclear bomb. The defence policy of Britain remains that of preparing against the risk of a world war, and so to endeavour to prevent it; the ultimate aim is the abolition of the use, possession and manufacture, not only of all nuclear weapons, but also of other weapons of mass destruction, together with simultaneous major reductions of conventional armaments and armed forces to agreed levels which would redress the present Communist superiority. Until, however, the Soviet Union agrees to participate in such a secure system of disarmament, the free nations must base their plans and preparations on the assumption that, if a major war were precipitated by an attack upon them, they would have to use all the weapons at their disposal in their defence.

Defence policy thus involves playing our full part in the defence of the interests of the free world as a whole, and particularly of the Commonwealth and Empire, in the 'cold war', as well as meeting the many other peace-time commitments overseas which arise from the position of Britain as a great Power with world-wide responsibilities. It is on the preparations against the risk of a world war that the existence of thermonuclear weapons has its main effect, and the outstanding feature of the White Paper is the way in which it analyses the implications of the assumption that the thermonuclear bomb is the primary deterrent against aggression. The power of the thermonuclear weapons exploded at Eniwetok and in the Marshall Islands is so much greater than that of the atomic bombs used in 1945 that accuracy of aim is less important. Attacks can be delivered by aircraft flying at great speed and at great heights, and while this alone greatly increases the difficulty of defence, there are no technical or scientific limita-

tions on the production of nuclear weapons of still more devastating power.

The United States Government has announced that it is proceeding with full-scale production of thermonuclear weapons, and the Soviet Government is clearly following the same policy. The British Government announces frankly that, having fully considered all the implications of this step, it has decided to proceed with the development and production of such weapons; and it is clear that the decisive factor has been the plain fact that the use of nuclear weapons is the only means of countering the massive preponderance in conventional land forces of the Soviet Union and its Eastern European satellites.

The reluctance with which the Government has reached this decision is not concealed in the White Paper, and it was obviously shared by the Opposition and the Government side alike in the defence debate. Nevertheless, while recoiling from the prospect of using nuclear weapons, the necessity was accepted by all but a small minority as the only alternative to militant Communism, with the oppression and national and individual humiliation that this would bring. To show weakness or hesitation to use all means of defence at our disposal would only increase the risk; and while the Statement depicts deliberately and sombrely the consequences which would follow if such weapons were used in war, realization by both sides of the grimness of the struggle which would result and the certainty that all pretensions to world domination would at once be destroyed, does paradoxically offer new hope. If the free world stands together, determined, if necessary, to defend itself with all its resources, the nuclear weapon may well increase the chances of world peace far more than the chances of world war. This may be true even when the present predominance of the West both in stocks of weapons and in the means of delivering them have been reduced. As the Prime Minister emphasized, in opening the debate on the White Paper on March 1, we may well have reached a stage "where safety will be the sturdy child of terror, and survival the twin brother of annihilation".

The recurrent theme of Sir Winston's speech was deterrence. Unless a trustworthy and universal agreement upon disarmament, conventional and nuclear alike, can be reached and an effective system of inspection established, he said, the only sane policy for the free world in the next few years is that of defence through deterrents. For that purpose, Britain must possess the most up-to-date nuclear weapons and the means of delivering them. That position appears to have been generally accepted in the debate. Confusion of thought arose, first, over the conditions under which thermonuclear weapons should be used and, second, over the need for maintaining conventional forces. As Sir Winston pointed out, the development of nuclear weapons will affect the shape and organization of the Armed Forces, as well as of civil defence, and the statements accompanying the Army and the Navy Estimates as well.

* Statement on Defence, 1955. Pp. 30. (Cmd. 9391.) (London: M. Stationery Office, 1955.) 1s. net.

as the Statement on Defence show that this is thoroughly realized, although the final shape is not yet clear. We cannot, however, sweep away our conventional weapons and forces: apart from our commitments to the North Atlantic Treaty Organization and the defence of Western Europe, substantial strength in such forces is still vital to enable Britain to fulfil its world-wide obligations.

Nevertheless, acceptance of the principle of deterrence or even of the order of priorities which it involves does not preclude criticism of the details of the Government's policy and programme as set out in the Statement. Indeed, the programme does not invariably conform to the order of priorities which it lays down, and there are sections, particularly those dealing with research and man-power, which are disturbing, and which suggest that the Government has not yet fully thought out the implications. Nor does the Statement afford any evidence that, for all the emphasis placed on research and development, the Government appreciates the extent to which successful defence is based on science, which in turn is dependent on preservation of the conditions which promote creative scientific activity.

The Statement on Defence could well be read in the context of the address on "Science and National Security" which Dr. L. A. Du Bridge delivered last October at the Johns Hopkins University and which has recently been published in *Science* (120, 1081-5; 1954). Dr. Du Bridge discussed frankly the ways in which science and technology promote national security. Without attempting to trace all the roots of national strength deep in the national way of life and the industrial, social, educational and economic systems, he began with the now generally accepted view that both military and industrial technology are rooted in fundamental science. From this it follows that fundamental science should be fostered by the government for four practical reasons: the dependence of progress on new knowledge; workers in fundamental science, being among the ablest and most imaginative in the country, provide an invaluable reserve immediately available at need to accelerate the development of military technology; the dependence of a continuing supply of scientists and technologists upon fundamental science in the universities; and the contribution of fundamental science to industrial technology, both in respect of new knowledge and of inspiring the workers in applied science.

Dr. Du Bridge's review of the steps taken in the United States in recent years to strengthen the position of fundamental research need not be considered here, apart from his reminder that it is still necessary to convince both industry and governments of the value—even from the point of view of defence alone—of encouraging fundamental research. His observations on the conduct in the United States of research for military purposes by the Department of Defense and the Atomic Energy Commission, and the differences between such applied research and fundamental research, however, bear closely on the immediate problem in Britain of the organization of science for defence. For one thing, Dr. Du Bridge regards variety of pattern in carrying out such

applied research as having advantages. Diversity of approach and individuality are conducive to new ideas: but there is also a danger of scattering resources and so making them ineffective, of confusing policies and neglecting priorities.

Accordingly, with diversity of pattern, it is imperative that there should be one office to give guidance and co-ordination to all the Service agencies. In Britain this is the essential task of the Defence Research Policy Advisory Committee, and one of the disturbing features of the Statement on Defence is the absence of positive evidence that that Committee is discharging its task effectively. Moreover, defence research and the scientific and technical resources required for defence policy also need co-ordination with the requirements of civil research in industry, government departments, and nationalized organizations and the universities. There is little indication that such co-ordination exists; though the Joint Intelligence Bureau recently formed (see *Nature*, March 26, p. 529) and the creation of a post of Scientific Adviser to the Minister of Defence are steps in that direction.

Before considering that position more closely, Dr. Du Bridge's observations on the promotion of research in general deserve to be noted. Whether in fundamental or in applied researches, success is the outcome of good ideas, and ideas cannot be manufactured on a production line. We do not understand how they arise; but we know a good deal about the conditions which encourage the birth of ideas. Dr. Du Bridge details some of those conditions or rules, and points out that what is required is to see that they are applied flexibly and with imagination and understanding in each organization, and appropriately for the purpose to be served. Nor does it follow that the conditions under which they are successfully applied for one purpose in one organization will be appropriate and successful for another, even in the same organization. What is required is something more than the provision of adequate facilities, resources and even information: it is the environment or the atmosphere and the administrative apparatus that are all-important. These can stimulate creative thought and imagination, or they can repress by engendering frustration and interruption. The danger is that the effect of factors outside the control of the research organization will be overlooked; otherwise it would not have fallen to the individual scientist and his professional associations to make the main protests against the secrecy regulations and restrictions on the exchange of information or the movement of scientists beyond the minimum that can be demonstrated as essential for security.

Beyond this, Dr. Du Bridge makes an important point when he argues that the process of bringing together scientific and military experience in the development and use of new weapons should be continuous, and that the responsibility lies equally on the scientist and on the Services. The scientist working in a laboratory devoted to military purpose should keep himself continuously informed of the broad military problems as well as of the specific one in his own field, just as the Service officer should be

thinking about technological possibilities. They should be continually exchanging ideas about problems. The first object of a scientific policy of defence should be to promote as effectively as possible the broad, intimate and vigorous discussion between scientists and Service officers on the problems of defence.

BIOLOGY AND RADIATION

Radiation Biology

Edited by Alexander Hollaender. Vol. 1: High Energy Radiation. Part 1: Chapters 1 to 8. Pp. ix+626. Part 2: Chapters 9 to 19. Pp. 627-1265. (Prepared under the Auspices of the Committee on Radiation Biology, Division of Biology and Agriculture, National Research Council, National Academy of Sciences, Washington, D.C.) (London: McGraw-Hill Publishing Company, 1954.) 140s. the two parts.

Medicina Nucleare

Introduzione alle Applicazioni Medico-Biologiche della Fisica Nucleare. Di Aldo Perussia, e coll. Pp. xii+878. (Roma: Il Pensiero Scientifico Editore.) 7000 lire.

Biological Effects of External X and Gamma Radiation

Edited by Prof. Raymond E. Zirkle. Part 1. (National Nuclear Energy Series: Manhattan Project Technical Section. Division 4—Plutonium Project Record: Vol. 22B.) Pp. xxvi+530. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 58s.

RADIATION biology is an artificial creation of man: Can it rank as one of the natural sciences? A reviewer of "Radiation Biology", edited by A. Hollaender, may well wonder whether it is indeed a subject in the academic sense any more than, for example, arsenic biology would be. The importance to mankind of the biological effects of radiation is clearly increasing, and in fact has provided the stimulus and support for most of the newer work summarized here. But radiation, apart from its toxicological importance, may be a useful investigating tool (pre-eminently perhaps in genetics), and also sometimes a useful technological accessory, as in the development from irradiated *Penicillium* of strains giving a higher yield of penicillin. These diverse aspects do not really make up a logical whole. A symptom of a common confusion of thought is the statement that the use of radioisotopes as a research tool is omitted because adequate texts are already available; a more valid reason is logical incompatibility.

In these volumes, about one-quarter is devoted to effects of radiation on the mammal, two-fifths to various aspects of chromosomal damage, one-fifth to the physical principles underlying the interaction of radiation and matter, and one-twentieth to biochemical effects. In general, the many authors have provided a fair historical perspective within which to set more recent advances, and their treatment, if not exhaustive, is comprehensive. The earlier chapters on the interaction of radiation and matter are more didactic in manner than those written by biologists; but the primary effects of radiation are reasonably well understood, whereas as yet there are few general principles which might unify the great variety of biological observations. The way in which

the primary effects of radiation are converted into chemical and hence biologically observable changes is almost unknown. These volumes should serve well their declared purpose of providing a standard book of reference.

"Medicina Nucleare", edited by Aldo Perussia, is an introduction to the biological and medical applications of nuclear physics. It is divided into four main parts dealing respectively with theoretical bases and general techniques; instrumentation, techniques and methods of detection and measurement of radiations; radioactive isotopes in biological research and clinical investigation; and applications of nuclear physics to radiotherapy. Of the twenty-one chapters, fifteen are by A. Perussia; the remaining six are by C. Salvetti (elements of nuclear physics), E. Gatti (the artificial production of radiations), M. Silvestri (nuclear reactors and the production of radioisotopes), L. Malatesta (radiochemistry), E. Gatti and A. Perussia (the principal means of instrumentation), and U. Facchini and A. Perussia (techniques and methods of measurement). There are appendices on the biological risks of ionizing radiations and isotopic data, and a bibliography of books and journals. The book deals adequately with the present status of a large and rapidly expanding branch of biological science: it will probably become the standard Italian-language text-book in its subject.

"Biological Effects of External X and Gamma Radiation", edited by R. E. Zirkle, is in rather a different category. As the editor points out, the work reported was carried out between 1942 and 1945 as war-time research; it was written hastily and not afterwards edited carefully for a variety of good reasons. It is therefore not meant to be a polished and complete work in any respect. To radiobiologists much of the work described is now past history. The individual papers are the records of investigations carried out at the National Cancer Institute by the late Egon Lorenz and his group, and at Chicago by L. O. Jacobson, E. S. Guzman Barron and their colleagues. These were at first considered as classified information; later they were made available with limited circulation, and parts were published in scientific journals. The novelty of many of the papers has thus faded; but some contributions have been brought up to date. Even if their current interest is limited, nevertheless it is valuable to have these reports now in a bound collected form ready for the library shelf in any part of the world.

R. H. MOLE
T. C. CARTER
J. F. LOUTIT

PROGRESS IN PHYSICS

Reports on Progress in Physics

Edited by A. C. Stickland. Vol. 17 (1954). Pp. iv+280. (London: Physical Society, 1954.) 50s.

VOL. 17 of the "Reports on Progress in Physics" is on similar lines to its immediate predecessors. It contains eight rather specialized articles of varying length, each dealing with recent advances in a particular branch or field of physics, the emphasis this time being on theoretical aspects. A useful innovation now introduced is that, in addition to the bound volume, paper-covered copies of the individual articles can be purchased separately at appropriate rates.

The longest article, some sixty-six pages, in the volume is contributed by C. J. Bouwkamp, who gives a masterly treatment and critical review of recent progress in classical diffraction theory. The main emphasis is on planar diffraction from the point of view of wave equation plus boundary conditions. The diffraction of guided waves is included, and both scalar and electromagnetic problems are discussed. Various modifications of the Kirchhoff and Kottler theories are dealt with, and the usefulness of variational techniques for the solution of a great number of diffraction problems is emphasized. In particular, the recent rigorous formulation of Babinet's principle in electromagnetic diffraction is described, and a brief impression is given of recent work on other problems in diffraction theory not dealt with in detail elsewhere in the article. The report concludes with a list of references to more than five hundred papers published since 1940.

Three reports deal with various aspects of nuclear and atomic physics: M. H. L. Pryce discusses nuclear shell structure; E. Teller the theory of the origin of cosmic rays; and W. Moffitt atomic valence states and chemical binding. Considerable evidence has been accumulated, particularly during the past six years, of the marked regularity of nuclear properties. The breaks at 2, 8, 20, 28, 50, 82 and 126 protons and neutrons and the arrangement of the so-called magic numbers at which closed shells occur into the two sequences A and B represented by $n(n+1)$ ($n+2$)/3 and $n(n^2+5)$ /3 respectively, illustrate this quite clearly. Prof. Pryce summarizes the experimental and theoretical data in support of this arrangement and discusses the various models of nuclear shell structure, including the individual-level model with its limitations and success and the collective model of A. Bohr, which have been advanced recently to explain the regularity. He points out, however, that our knowledge of the origin of nuclear forces is still too slight to obtain a complete picture.

In his all-too-brief report of nineteen pages, Prof. Teller describes in a most fascinating way what primary cosmic rays consist of, how a relatively soft and minor component of the cosmic radiation originates from the sun, and that the random acceleration process, proposed by Fermi, and a physical location of the accelerating fields in radio stars, as suggested by Unsöld, together account satisfactorily for the main features of cosmic radiation. His discussion of the lasting effects that a great burst of cosmic ray intensity, which may have occurred in the far distant past, may have produced on our existing civilization is particularly interesting. W. Moffitt, in presenting a very general theory of the electronic structure of molecules, pays especial attention to the electron-pairing theory of chemical binding due to Slater and Pauling, and Van Vleck's valence-state concept is illustrated with respect to certain simple molecules. Orbital hybridization and the heteropolar character of certain bonds involving the establishment of an electronegative scale are also discussed.

The subject-matter of A. B. Lidiard's important article on antiferromagnetism is divided into two parts. The first deals with the paramagnetic transition metals of the iron series, and the second with a number of compounds of the transition metals (including the ferromagnetics, iron, cobalt and nickel) with elements of groups V, VI and VII of the Periodic Table. Recent experimental studies, par-

ticularly by the use of neutron diffraction, are surveyed, and on the theoretical side, Van Vleck's approximate theory and its improvements, both by extending the model and by using more accurate statistics, are considered. A discussion of the superexchange mechanism is included. The article concludes with a comprehensive and extremely useful table listing experimental papers on antiferromagnetism arranged by compound and by the property studied.

The remaining three articles deal with atmospheric phenomena. "Atmospheric Electricity" by J. A. Chalmers, an acknowledged authority on the subject, is largely a supplement to his recent book and suffers from too much sectionalization. A number of current problems are discussed briefly in turn. "Horizontal Movements in the Ionosphere", by B. H. Briggs and M. Spencer, is a survey of existing knowledge as obtained by radio methods. The authors, working in Cambridge, have themselves used the method of reflected radio waves observed at closely spaced points, and this method and results obtained by it are given most prominence, though other methods are dealt with more briefly. A discussion of the important but difficult question as to whether the movements in the ionosphere detected by the various radio techniques are true movements of the air or merely movements of the ionization is not attempted; but the various results obtained in Cambridge and elsewhere are carefully compared and contrasted.

Finally, the experimental observations from which the physical conditions of the solar corona may be derived are briefly reviewed by C. W. Allen, of the University of London Observatory. It is stated that during the past ten years so much has been learned about the corona that it is now a most useful astrophysical body for the accurate study of the activities of atoms at high temperatures. However, the irregularity and variability of the corona is still somewhat of a limiting factor. The picture of the corona which has been produced is one in which the physical effects are associated with the high temperature. The dynamical effects are also profoundly influenced by this temperature; but it is not high enough to account for all the ejection of coronal material as evidenced by the streamers and geomagnetic storms. Additional outward forces are required, the origin of which is not at present understood.

S. WEINTROUB

A CITY NATURALIST'S MUSINGS

A Naturalist's Life of New York

By Dr. William Beebe. Pp. x+165. (London: The Bodley Head, 1954.) 12s. 6d. net.

THE title of this book is somewhat misleading. It is not a natural history of New York in the strict sense, but a series of most enjoyable short essays woven around the prehistoric and modern geology and wild life of the district around New York. While, of course, Dr. Beebe's name is a guarantee that the scientific accuracy of the facts is impeccable, the somewhat light-hearted approach of the chapter-headings—"Too Old to be Seen", "Too Small to be Seen", "Too Disguised to be Seen", and so forth—is somewhat deterring to a British reader, accustomed to a more serious approach to what has become in some circles almost a semi-sacred subject. Americans often express surprise at the large number

of popular natural history books that appear in Britain, and it is evident from the present volume that in the United States even so eminent a naturalist as Dr. Beebe has to dress his material up to a degree that is fortunately unnecessary over here.

One series of essays is based on the palaeontology of the New York region, and discusses creatures like the sabre-toothed tiger, mammoth, walrus and ground sloth. It is interesting to be reminded that the great-clawed ground sloth, remains of which were found in a cave eighty miles from New York, was given its generic name, *Megalonyx*, in a paper written in 1797 by Thomas Jefferson, later the third President of the United States. The next series of essays gives the historical view of wild life from the period when written records became available at the beginning of the seventeenth century. Manhattan is said to have been named by the Delaware Indians from the general intoxication that occurred when, according to the Indian legend, the first white men arrived and introduced the natives to the contemporary equivalent of a cocktail. In 1770, we learn, the inhabitants of Westchester County had to discover, in the hard way, that a bounty is an inefficient method of controlling wild animals. The 20s. for a wolf offered in an ordinance in that year had six years later to be increased to £3. Even to-day it is doubtful if many 'practical men' have grasped the fact that animal populations are remarkably resilient, and that what passes for 'control' is usually merely a slight depression of numbers that it is well within the capacity of the population to replenish. There is often no halfway house between the wasted effort of a regular thinning and near-extirmination.

Among the essays on contemporary wild life in and around New York, those that deal with birds are the most likely to interest readers in Britain. We learn that fifty years ago sixty species of bird nested in Central Park, and that some two hundred have been recorded there at one time or another. To-day only half a dozen breeding species remain, and Dr. Beebe attributes the decrease to atmospheric pollution by automobiles, which is accentuated by the steady closing in of lofty buildings. In a fascinating essay, Dr. Beebe describes how in 1904 he anticipated our modern passion for migration-watching by spending a night in the torch of the Statue of Liberty, which sways two feet in the wind.

The book is illustrated with delightful little humorous sketches by Donald T. Carlisle.

R. S. R. FITTER

HOME-LIFE OF THE ATLANTIC SEAL

The Seals and the Curragh

Introducing the Natural History of the Grey Seal of the North Atlantic. By R. M. Lockley. Pp. vii+149+8 plates. (London: J. M. Dent and Sons, Ltd., 1954.) 15s. net.

IN this book R. M. Lockley gives us a remarkable insight into the home-life of the grey or Atlantic seal. F. Fraser Darling has already studied and written of this animal at some of its Scottish haunts; but the book under review is a more intimate study, for the author literally lived with the seals during the breeding season, and largely won their confidence. He wisely does not give the site of his seal nursery; but we are told that it is somewhere

on the coast of Wales, where, incidentally, great mortality to the young seals must have resulted from the hurricanes of November 1954.

The author sailed by himself to the remote beach where the seals have their young, and having drawn up his curragh (which he tells us was a gift from Eire) above high-tide mark, slept beneath it for a month, studying the seals, which almost accepted him as one of themselves. Many of the things he saw had never been seen by man before, and he has recorded his observations in the masterly prose which those who have read his earlier books have come to expect of him. He watched the birth of the seal calves, and weighed them daily. One of them (p. 51) increased in weight for the first ten days at an average rate of 3 lb. during each twenty-four hours. At its Scottish nursery islands, the Atlantic seal is a land animal for at least a fortnight after birth; but the author (p. 53) records that he watched a seal calf called to the sea by its mother for a swimming lesson (returning to the beach later) on the third day of its life. The gestation period of the Atlantic seal is almost twelve months, and when this calf was fourteen days old its mother mated with a bull (p. 58). The author (p. 84) saw the seals mating under water, the animals being entirely submerged.

The author describes the little-known 'spring dances' of the seals and has watched what would appear to be a habitual second mating at this time.

The book is illustrated by excellent photographs, and a map of the distribution and breeding places of this seal in Britain. His map gives the Island of Mull area as a larger breeding ground than the Outer Hebridean breeding area—Shillay, Gasker and Hasker—but on these three latter islands probably three times as many Atlantic seals are born as in the Isle of Mull area.

The publishers are to be congratulated on the format of the book, on the excellence of the paper, the printing, and the binding. SETON GORDON

CRYSTALLOGRAPHIC STRUCTURE REPORTS

Structure Reports for 1945-46

Vol. 10. Pp. viii+325. 45 florins; 12 dollars; 84s.

Structure Reports for 1950

Vol. 13. Pp. viii+643. 80 Dutch florins; 21.50 dollars; 151s.

Edited by A. J. C. Wilson. (Utrecht: N.V.A. Oosthoek's Uitgevers Mij, 1953-54. Published for the International Union of Crystallography.)

THE successive appearance of Vol. 10 (1945-46) and Vol. 13 (1950) of "Structure Reports" is in accordance with the plan of starting after the War with Vol. 11 (1947-48) and working in both directions, so as to keep the series relatively up to date while making up the back-log as soon as possible. The abstracts maintain the high standard of accuracy and thoroughness characteristic of former volumes, and a feature which is particularly welcome to English-speaking readers is, as would be expected from an International Union, the excellent coverage of foreign journals, including those published in Russian. This must, however, add considerably to the work involved, and a recent advertisement for a full-time assistant editor directs attention to the heavy expense of adequate abstracting. Indeed, the

price already makes it almost impossible for individual research workers, to whom they are well-nigh indispensable, to buy these abstracts.

The work involved might well be less if published papers always contained the data given in "Structure Reports". In the judgment of the editorial board, this particular range of information is thought to be sufficiently important to be inserted even if the abstractors must calculate some of it themselves in order to include it. In these circumstances the International Union of Crystallography might perhaps require all appropriate papers submitted to its own journal, *Acta Crystallographica*, to contain this information in the desired form, and possibly make general recommendations about the publication of papers on structural crystallography.

The amount of work sometimes undertaken by abstractors is indicated by the report on AsCuZn, where the abstractor's comment almost constitutes an original publication on the subject, while the collection of data on a particular topic, such as manganese oxides, is nearly as valuable as a review article; and since these later volumes contain cross-references to earlier ones, and occasionally, as for β -uranium, relevant comments from papers published as recently as 1954, the series does constitute an extremely valuable work of reference.

A general comparison of the two volumes illustrates the rapid development of crystallography since the end of the Second World War. Topics almost if not completely absent from Vol. 10 which have appeared or expanded by 1950 include crystal structure determination by means of electron and neutron diffraction, bond-length and bond-angle determinations by microwave methods, the preparation and elucidation of clathrate compounds of the rare gases, the use of statistical methods in the interpretation of X-ray diffraction data, and the determination of the absolute configuration of an optically active compound.

Mention of the use of etch figures in space-group determination comes as a welcome reminder of the many older physical and morphological techniques which crystallographers of the new generation, conscious of the importance of X-rays, often and perhaps unwisely neglect. On the other hand, crystallographic data for a number of proteins remind us that X-ray diffraction methods have already made a contribution to biochemistry, and now seem competent—at least in principle—to solve structural problems complex beyond all but the wildest dreams of even twenty years ago.

H. J. GRENVILLE-WELLS

ELECTRONICS IN THE PHYSIOLOGICAL LABORATORY

An Introduction to Electronics for Physiological Workers

By Dr. I. C. Whitfield. Pp. ix+236. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1953.) 18s. net.

THE rapid advances in electronic techniques during the Second World War have influenced research in physiology, so that most laboratories now have a quantity of electronic equipment. Many new research students in biology have to grapple with this equipment, about which they have no know-

ledge. This has inevitably induced the appearance of a number of books intended to make biologist familiar with the new techniques. Some have been merely collections of circuits; those which have attempted to teach electronics have generally begun simply but have quickly become technical in idiom and mathematical, so that the biologist loses contact and flounders on despairingly. This is another book introducing the biologist to electronics, but one in which the author manages throughout to keep at steady level of treatment comprehensible to its intended reader. It is emphasized that this book is not intended for 'idle hour' reading; and although at the end the reader will not be able to design circuits, he should be able to understand the operation of equipment commonly used in electrophysiology.

The first chapters introduce the simple concepts of direct and alternating current supplies. Apart from a tendency to use alternative terms indiscriminately (for example, voltage and potential), the style is clear. Analogies to commonplace events can be misleading and a considerable number are included but the consistently skilful treatment makes them informative and attractive. It is surprising that so much ground can be covered in two chapters and still provide an intelligent concept of such topics as load matching, time constant and resonance. The author continues with a brief consideration of thermionic emission, followed by careful description of multi-electrode valves. Particular attention is given to their dynamic characteristics and to equivalent circuits for triodes; but the pentode is dismissed very briefly. A sketchy introduction to simple multi-stage amplifiers precedes a digression to gas-filled tubes and photocells. The various types of photocell are described and their limitations emphasized.

Power supplies and rectification are next considered, and the description of each type of rectifier circuit is very instructive. The practical problems of regulation and ripple attenuation are illustrated numerically; and although the method for estimating smoothing is unusual, it gives a picture without mathematical complication. Stabilization of power supplies comes in a later chapter: the dynamic characteristics of neon stabilizers are described and considerable attention paid to hard-valve stabilization.

The most interesting chapters to the biologist are those concerned with feedback, noise and biological amplifiers. The introduction to feedback is not very helpful, but the 'cathode follower' is explained well, the arithmetic is simple but demonstrates the effect on input and output impedances and hence the circuit applications. Sources of, and reduction of, noise and interference troubles are of practical value to most readers; but there is a surprising absence of information about elimination of stimulus artefacts which are troublesome to many electrophysiologists.

The book finishes with a description of display methods—the types of cathode-ray tubes, the operation and typical distortions. Trigger circuits, oscillators and time-bases are given extensive treatment. Most of the circuits in general use are mentioned, and in particular the flip-flop and the Miller time-base are very clearly defined.

This book does not attempt to attain a high level of technicality. It is intended to be simple and must be thus estimated. Criticism can be made of the lack of detail and of over-simplified explanation of mathematics; but the book keeps to its aim, and in that simplicity has its value. B. C. ABBOTT

isotopic Tracers

A Theoretical and Practical Manual for Biological Students and Research Workers. By G. E. Francis, W. Mulligan and Prof. A. Wormald. Pp. xvi+306. London: University of London. The Athlone Press, 1954. Distributed by Constable and Co., Ltd.) 7s. 6d. net.

THE authors of this book have experience both of teaching and using isotopic tracer techniques; they write on both theoretical and practical aspects of the subject. They describe the preparation, properties and measurements of radioactive and stable tracers and their compounds. The sections on autoradiography, health hazards and syntheses are excellent, and sound practical details are given for a variety of experiments which are biased in favour of biological investigations. Experimental data are frequently given in the form of useful tables and graphs. References are often made to original literature and other texts.

The book might be criticized on a number of points. The implications of the statistical interpretation of disintegration-rates should have been discussed in the text and not mainly in the appendix. The use of sodium hydroxide for the purification of zirconium oxide seems unwise; furthermore, the use of chromic acid is suggested instead of chromium trioxide. Their first definition of specific activity in terms of the ratio of numbers of atoms is not in general use; and even in their own experimental section it does lead to an anomalous situation (experiment 2).

In spite of these criticisms, the book can be recommended to biologists who wish to survey, or use, tracer techniques: even for biological students, however, more information on results would be desirable. Other research workers and teachers will find the book useful as a concise summary of the subject.

S. J. THOMSON

Come Beyond the Imperial Frontiers

By Sir Mortimer Wheeler. Pp. xii+192+38 plates. London: G. Bell and Sons, Ltd., 1954.) 25s. net.

IN this valuable work Sir Mortimer Wheeler presents a critical discussion of the extent of the diffusion of Roman objects, made in Italy or within the Empire, and draws conclusions on the results of the penetration of Roman influences during the first three centuries of the Christian era. The evidence is set with under the headings of Free Germany, Africa, and India and the Far East in this order. In the case of Europe this evidence is both literary and archaeological, and in presenting a masterly summary of this aspect Sir Mortimer draws largely on the recent extensive work of Eggers, of Broholm and others. His own conclusion is that Roman trade in Europe became important in the first century, when the spread was from Italy by way of the Danube to the Baltic and to Bohemia. About the end of the second century objects made in Gaul and the Rhineland were carried to the north-east and east. Later there was an extension from South Russia to Byzantium.

After a brief section on recent work in the Fezzan and the Hoggar in the Sahara, Sir Mortimer deals with the important discoveries in India, at Arikamedu, Taxila and Begram, with which he has been associated. His general conclusion is that the most important impact of the Western on the Eastern world occurred in the early centuries of the Christian

era, when it produced a significant change in Buddhist art.

The plates in this book are most carefully chosen. The evidence is assembled with the author's usual skill. A minor suggestion is that the concluding "Retrospect" emphasizes five imports, and the general reader might well read this section first.

John William Bews

A Memoir. By George W. Gale. Pp. 140. (Pietermaritzburg: University of Natal Press, 1954.) n.p.

PROF. J. W. BEWS, who died in 1938 at the early age of fifty-three, was for many years a leading figure in botanical circles in South Africa and was one of the foremost plant ecologists of his day. A well-written account, delayed by the War and other causes, of his life and work has now appeared. The author, who is dean of the Faculty of Medicine in the University of Natal, was one of Bews's early postgraduate students in botany at Pietermaritzburg. It was General Smuts, with whom Bews was on friendly terms, and with whom he shared a common interest in the grasses and grasslands of southern Africa, who first suggested that there should be some permanent record of Bews's life and work.

The book gives a detailed and interesting account of Bews's life, including his boyhood in the Orkneys, for he was the son of an Orkney farmer, his student days at Edinburgh, where he graduated in both arts and science, and his working-life in South Africa. In addition to his ability as an ecologist and as a teacher, Bews later proved himself to be an able university administrator. He was, in fact, one of the founders of university education in Natal. Many of his students now hold important botanical posts in South Africa. The writer gives a descriptive account of Bews's published work, of which there were seven books, including works on human ecology.

Squirrels

By Monica Shorten. (New Naturalist Special Volume.) Pp. xii+212+15 plates (London: William Collins, Sons and Co., Ltd., 1954.) 15s. net.

THIS admirable book combines the scientific approach with clear and attractive writing. It will be news to many of the author's readers that the supposed hibernation of the red squirrel is a myth. The animal cannot live for more than a few days without food, and has been watched in full activity in Switzerland when the thermometer stood at -15°C . The author, writing first about the red squirrel, tells us many interesting facts about it. The present race in Britain (like the capercaillie) has been introduced at various times, although the native stock may have survived in the counties of Sutherland and Inverness. Harvie Brown recorded a red squirrel on Beinn Bhrotain, a high hill in Mar 3,829 ft. above sea-level, at least nine miles from the nearest tree. This looks like migration between the Scots fir forests of Mar in Aberdeenshire and Glen Feshie in Inverness-shire. In her notes on the red squirrel's enemies (p. 36), the author does not mention the golden eagle, which preys on it in Scotland, in Switzerland, and in other lands.

The author tries to be fair to the grey squirrel, an unpopular immigrant from America, and she does not find it proved that its increase is the reason for the decrease of the red squirrel. The book is enriched by some excellent photographs and maps.

SETON GORDON

TWO GEOLOGICAL CENTENARIES

G. B. GREENOUGH, F.R.S. (1778-1855), and SIR HENRY DE LA BECHE, F.R.S. (1796-1855)

By V. A. EYLES and J. M. EYLES

IN April 1855 the geological world suffered the loss of two of its best-known figures, George Bellas Greenough and Henry Thomas de la Beche. One of them, Greenough, was a founder and first president of the Geological Society of London, doyen of the many geological societies established since; while to de la Beche we owe the establishment of the Geological Survey of Great Britain, a pioneer among such bodies.

At the opening of the nineteenth century, geology was a new science, completely unorganized, and in Britain the number of its devotees, nearly all amateurs, was comparatively small. Within the life-time of Greenough and de la Beche the position so changed that the science attained complete independence, with its own professional societies; and furthermore, its importance to the country obtained official recognition. This state of affairs was the result in no small measure of the efforts of these two men.

G. B. Greenough, originally George Bellas, had assumed the surname of Greenough while still a youth, on inheriting a considerable fortune from his maternal grandfather. He was educated at Eton and Pembroke College, Cambridge, and later studied law at Göttingen. Here, however, the lectures of the anthropologist, J. F. Blumenbach, seem to have implanted in him the taste for science, and for geology in particular, which largely determined the future course of his long life. From Göttingen he went to Freiberg to study under the eminent geologist, A. G. Werner, whose views he adopted and advocated for many years. After further travel he returned to Britain in 1801. Then for some years he took part in the activities of the newly formed Royal Institution, meeting Humphry Davy, with whom he visited Ireland in 1806. In 1807 Greenough was elected to Parliament as member for one of the pocket boroughs, that of Gatton, Surrey. Although he took his political duties seriously, after 1812 he seems not to have taken any further public part in politics.

While political activity was but a passing phase in his life, his interest in geology continued to grow. In 1807, a few months after being elected a Fellow of the Royal Society, Greenough joined with a dozen other enthusiasts to form what one of them called "a little talking Geological Dinner Club", becoming its treasurer and chairman (or president). This club was established by 1811 as a regular geological society, with Greenough as first president, and it began to issue *Transactions*. In 1825 the society was formally incorporated by Royal Charter as the Geological Society of London, which now has more than two thousand members.

The new Society had not escaped teething troubles, for during the first few years of its existence it met with serious opposition from the Royal Society, which, jealous of its own authority in the field of scientific inquiry, endeavoured to suppress the newcomer. It seems to have been due principally to the resistance of Greenough that the senior Society, in the person of its president, Sir Joseph Banks, and other prominent Fellows, was unsuccessful in its efforts.

Within a year or so of its formation, the new Geological Society set up a committee to encourage

the production of geological maps, then very much a novelty. On November 6, 1812, Greenough presented to the Society "Nine Maps of England with the principal Strata sketched in", and as a result was specifically requested to construct a geological map of England upon a large scale. He set about the task methodically, combining the results of his own field-work with that of other geologists. The resulting work, on a scale of 11 miles to the inch, was published by the Geological Society in 1820. Though now almost forgotten, it was for its time a work of great merit, superior in accuracy to the great pioneer map of William Smith, published in 1815. It went into a second edition in 1840 and a third in 1865.

Greenough continued for the rest of his life to serve the Geological Society in one way or another, either as a member of council or as president, an office to which he was re-elected in 1818 and again in 1833. He made no contribution to the publications of the Society other than his presidential addresses, but frequently took part in the debates which followed the delivery of papers, generally adopting a somewhat conservative and critical attitude when new ideas were discussed. His contributions to the literature of geology were, in fact, remarkably few, in view of his long association with the science, though in 1819 he published a series of essays entitled "A Critical Examination of the First Principles of Geology". These are now of historical interest only; but they afford a well-documented record of views held and arguments used in the geological discussions of the period.

Greenough also spent many years in compiling a large geological map of India, the first of its kind, which he exhibited to members of the British Association at Liverpool, in 1854. Incidentally, it is worth recalling that he was present at the first meeting of the Association, at York in 1831.

Closely allied to Greenough's predilection for geology was his interest in geography; when the Geographical Society was founded in 1830, he served on its first council, and was elected president in 1839. The science of ethnology, too, claimed some of his interest and attention.

About 1822 Greenough commissioned a young architect, Decimus Burton (later one of his executors), to build him a house in Regent's Park, London. Known as Grove House, it was deemed sufficiently noteworthy at the time to be illustrated in contemporary publications. A coloured view of "The Seat of G. B. Greenough Esq." appeared in R. Ackermann's "Repository of the Arts etc." in 1828. The house still stands at the north end of Park Road, beyond Hanover Gate. In 1953 it was acquired by the Nuffield Foundation, who have, regrettably, renamed it Nuffield Lodge. Here Greenough entertained his friends and fellow scientists at dinner parties and soirées, during which scientific matters were the main topic of conversation. Here, too, he housed his extensive collection of books and maps, which on his death passed to the Geological and Geographical Societies. His collection of rocks and fossils went to University College, London, with the foundation of which he is said to have been closely connected. His name is still

commemorated there by the Greenough Club, in the Department of Geology.

Greenough is said to have been of pleasant but shy and modest disposition. He was a distinguished representative of a type seldom met with to-day—an amateur, in the true sense of the word, well versed in science, who had the means and inclination to make science his career. Although Greenough made no great contributions to scientific knowledge, it is quite clear that by his own labours, and by his encouragement of others, with financial assistance or otherwise, and by his long service on the councils and as president of scientific societies, he contributed much to the advancement of science as a whole. His singleness of purpose persisted to the end of his life. It is best illustrated by the fact that at the age of seventy-six, after taking the precaution of making his will, he set out for Italy and the East, bent on further geological and geographical researches. Illness prevented him travelling beyond Naples, where he died on April 2, 1855.

Henry Thomas de la Beche became a member of the Geological Society in 1817, when he was twenty-one, shortly before Greenough assumed his second presidency. His early years had been spent at Charmouth and Lyme Regis, in a district then becoming famous for its fossil remains, and this may have led to his early interest in geology. At all events, in 1819 he read a paper on the geology of the coast between Bridport and Babbacombe Bay to the Geological Society. In the same year he became a Fellow of the Royal Society. He travelled widely on the Continent as well as in England and Wales to increase his knowledge of geology. In 1824 he visited family estates in Jamaica and on his return described the geology of the island to the Geological Society.

De la Beche made numerous valuable contributions to geological literature; but, in retrospect, the most significant task he undertook was when about 1830 he began to colour geologically some of the new one-inch to the mile maps of the Ordnance Trigonometrical Survey. The importance of this work was appreciated, and in 1832 he received a grant from the Treasury to enable him to continue it. In 1835 he was appointed on a salaried basis to continue his geological mapping, and this year is accepted as that of the foundation of the Geological Survey of Great Britain. The story of the early years of the Survey has been told more than once, and it is clear that De la Beche was particularly well fitted to be the first director of this new national scientific service. He was not only a distinguished geologist, but also proved himself an able administrator, possessing to a marked degree the qualities of tact, firmness and an understanding of the official mind so necessary to one in his position. Some years ago, Dr. F. J. North published extracts from De la Beche's correspondence and note-books¹, which gave clear evidence of this ability. Other letters of De la Beche (so far unpublished) are preserved among the correspondence of Sir Robert Peel now in the British Museum. From these letters it is evident that the Director of the new Geological Survey had no hesitation in by-passing the 'usual channels' and making a direct approach to higher authorities, when he deemed it necessary. In 1841 he wished to obtain sanction for an increase in his financial estimate for 1842-43, from £1,400 to £1,900. For this increase he had a good reason, namely, the addition to his staff of two new men, John Phillips, the palaeontologist, and young Andrew Ramsay, later to become director himself.

Nevertheless, it was not a good time to seek permission from the Treasury for an increase, however modest. The national finances were in an alarming state, with a falling revenue and a rapidly mounting deficit. In August 1841, a Tory government with Sir Robert Peel as premier had replaced Lord Melbourne's Whig government, and drastic measures were expected. The winter of 1841-42 proved to be one of the worst, economically and industrially, through which Britain has ever passed. Yet, on November 1, 1841, De la Beche wrote from Fishguard to Canon Buckland, then president of the Geological Society as well as professor of geology at Oxford, explaining his apprehension over his estimate; and suggesting that a direct approach to Sir Robert Peel would be of assistance. Buckland immediately forwarded this letter to the premier, with a covering note containing a warm recommendation of De la Beche, his work and his staff. On November 8, with remarkable promptitude and commendable brevity, Peel replied: "My dear Dr. Buckland, Pray assure Mr De La Beche that the Geological Estimate which he proposes for the ensuing year shall undergo no curtailment. Most truly yours, Robert Peel".

It is an interesting sidelight on the character of the great politician and financial minister to find that at such a time he showed no inclination to allow cheese-paring at the expense of a scientific service. It should be remembered of course, that Peel had been a Fellow of the Royal Society since 1822, and had become a Fellow of the Geological Society in 1840, so that some sympathy towards science was not unexpected. However, only six months later, he was to introduce a Budget in which, faced with a deficit of more than two million pounds, he imposed an income tax of 7d. in the £—a most unpopular measure, for there had been no direct tax on income since the war ended in 1815. Cideon Mantell, another well-known geologist, recorded in his journal on May 18, 1843: "Went into the City and received my dividends at the bank: Peel's rascally tax being subtracted from my hard earnings".

The economic worth of the work then being carried out by the Geological Survey in the South Wales coalfield was undoubtedly appreciated; and the award of a knighthood to De la Beche in April 1842 no doubt indicated that Peel valued his services highly.

A few years later, in August 1844, De la Beche again asked Buckland to approach Sir Robert Peel. This time he pointed out the disadvantages of the Geological Survey's subordinate position under the Trigonometrical Survey, which had its headquarters in Southampton, and was itself in turn controlled by the Board of Ordnance. The Museum of Economic Geology, which Sir Henry also directed, was administered by the Department of Woods and Forests, and a transfer would bring the Survey and the Museum under one head, and the Survey itself into closer relation with mining and agriculture. This application also was successful, and the Treasury minute of December 27, 1844, affecting the transfer, was drawn up by Peel himself.

In 1848 Sir Henry de la Beche, then a member of the Council of the Royal Society and also president of the Geological Society, was entrusted with the delicate task of discovering whether Peel (no longer holding political office) would stand for the presidency of the Royal Society, then becoming vacant by the resignation of Lord Northampton. An account of the meeting is recorded in a memorandum by Peel, who

wrote, *inter alia*: "I replied that I was prepared to give an immediate and decisive answer—that in my opinion the President of the Royal Society ought to be a distinguished man of science . . . that I would oppose any other nomination than that of a man of science". In the event, Lord Northampton was succeeded by William Parsons, third Earl of Rosse, and a distinguished amateur astronomer.

Peel died suddenly in 1850, and so did not witness the great events of 1851. In this year, on May 12, the new Museum of Practical Geology in Jernyn Street was opened by the Prince Consort; and in the following November the Government School of Mines and of Science applied to the Arts (now the Royal School of Mines and the Royal College of Science) was opened in the same building, with Sir Henry de la Beche as its first president.

This was the climax of De la Beche's career. In 1853 his health began to deteriorate, although he continued to attend regularly at his office. Early in 1855 he was awarded the Wollaston Medal by the Geological Society; but he was already confined to a wheel-chair by partial paralysis. He died on April 13 at the early age of fifty-nine, only two days after his last visit to the Museum. Sir John Flett, director of the Geological Survey during 1920–35, wrote of De la Beche in his centenary history of the Survey: "He had lived to see the fruition of his great designs, and to-day at South Kensington the Geological Survey and Museum and Royal School of Mines, housed in magnificent buildings, form a striking monument to his far-sighted policy and sound judgment. Nothing that he did has failed and with the progress of the years all his projected enterprises have expanded and developed".

¹ *Nature*, 143, 254 (1939).

SIR JOHN BLAND-SUTTON, BART. (1855–1936)

By W. R. BETT

A HUNDRED years ago, on April 21, 1855, at Enfield, Middlesex, was born John Bland Sutton, the eldest son of a market gardener, butcher and amateur medical practitioner, and later to become the most eminent pathologist-surgeon of his day and a great naturalist in the tradition of John Hunter, whom he worshipped. Like Hunter, he was brought up in the country, and like Hunter, he was proud of his humble origin and, indeed, also of his Cockney accent. At the age of ten he was taken to see Hunter's house in London, at Earl's Court, and the den in the garden where the menagerie of wild animals was kept; and ever after, this great surgeon-naturalist remained his kindred spirit. Having worked for two years as a school-teacher, Sutton decided to become a surgeon and, like his hero, approached surgery through anatomy and comparative anatomy. After a preliminary grounding at Thomas Cooke's private school of anatomy in Bloomsbury, he entered the Middlesex Hospital Medical School in 1878 at the age of twenty-three, and while still a student was appointed prosector of anatomy, and in the following year junior demonstrator. Having no money to spend on sport and social diversions, he worked all day and far into the night. He was a popular teacher, whose witty demonstrations came to be known as 'Sutton's

entertainments'. In 1882 he qualified as a medical practitioner, and two years later obtained the fellowship of the Royal College of Surgeons. In 1886 he was elected assistant surgeon to the Hospital and lecturer on anatomy in the Medical School.

Sutton's long and intimate connexion with the London Zoological Gardens began with his appointment in 1881 as prosector, and for five years he performed the post-mortem examinations on all the animals dying in the Gardens. Many of his findings formed the basis of his first book, "Ligaments: their Nature and Morphology" (1887), which revolutionized anatomy by explaining some of its anomalies in the light of morphology. In "Evolution and Disease" (1890) he attempted to show that there is a natural history of disease, as well as of plants and animals. Keenly interested in the problem of rickets in young lions at the Zoo, he fed them a diet of cod-liver oil, bone dust and infant's food, but this was not "a pecuniary success".

Around 1889 a Dr. J. B. Sutton opened a shilling dispensary in the Euston Road. As this was rumoured to be Bland Sutton's venture and he was frequently called out in the night for "cheap midwifery", he assumed the name of Bland-Sutton by deed poll.

A new chapter in Bland-Sutton's life started in 1896 when he was elected surgeon to the Chelsea Hospital for Women, which he rapidly made the Mecca for pelvic surgeons from all over the world, for he created the gynæcological surgeon in place of the gynæcologist. When he first performed hysterectomies for fibroids he was called "a criminal mutilator of women"; but he was later hailed as a pioneer who disestablished the "cough-invalid", rendering her capable of earning her own living or becoming a companion to her husband. He made a fortune out of hysterectomies and for a time appeared to lose interest in general surgery. He was the first to remove a tubal mole, which he made a familiar condition to the gynæcologist, and his papers on the origin of ovarian cysts in animals, on ovarian dermoids and on menstruation in monkeys were classics in their day.

For many years regarded as the surgeon to the dental surgeons, Bland-Sutton was an honorary member of the Odontological Society, before which he read valuable papers on comparative dental pathology, and to him we owe the first scientific classification of odontomes. His book "Tumours, Innocent and Malignant" (1893, seventh edition 1922) was a 'best-seller' and won him world-wide fame. It was so copiously and so dramatically illustrated as to make the text seem almost superfluous; the author had no use for photographs, and rendered a great service to medicine and to literature by resuscitating the art of wood-engraving. A fluent and attractive writer and speaker, he was forceful, witty and adept in producing unexpected similes.

A knighthood was conferred on Bland-Sutton in 1912, which was followed by a baronetcy in 1925, and he served as president of the Royal College of Surgeons of England during 1923–26. He had now reached the summit of his surgical career and fame and of his ambition. As an operator he was incredibly quick and used the minimum of instruments. In profile he bore a marked resemblance to Napoleon, and he had many Napoleonic traits in his mental make-up, such as self-reliance, ambition, natural leadership of men, coolness in a crisis, and aloofness of personality. His beautiful dining-court in Brook Street, an exact replica in miniature of the hall of honour in the

palace of Darius the Great at Susa, was one of the sights of London and the frequent scene of lavish dinners, which were attended by the greatest men and women in the land.

Bland-Sutton was a keen traveller and made some fifty voyages to various parts of the world, which he described in memorable books and essays, such as "Man and Beast in Eastern Ethiopia", "Spolia Nemoralia" (an account of the shrunk heads of the Aguaruna Indians), and "The Science of the Bull-ring". He retired from the Middlesex Hospital in 1920 and died on December 20, 1936, at the age of eighty-one. When he started on his career, the path to surgery lay through the dissecting room. Foreseeing "the need of a more intimate association between the care of living patients and the study of disease" and anticipating the day when the path to surgery would lie through the pathological institute, in 1913 he presented to the Middlesex Hospital the Bland-Sutton Institute of Pathology. It is fitting that his ashes rest in the museum of this Institute, near his marble bust by Sir George Frampton: "A Seeker after Knowledge that should Avert or Mitigate Pain".

THE PROPERTIES OF SOLID ARGON

A MEETING of the Low Temperature Group of the Physical Society, held on February 8, was devoted to the properties of solid argon. Dr. K. Mendelssohn presided, and in his opening remarks emphasized that the simplicity of the atomic structure of the inert gases makes them valuable instruments for the exploration of the general physical properties of matter.

Prof. G. O. Jones mentioned briefly some researches into the properties of solid argon in progress at Queen Mary College (University of London), and described in detail work being carried out by Mr. B. F. Figgins on the specific heat of solidified argon-krypton mixtures of simple atomic proportions (1:1 and 1:3). Argon and krypton are known to form solid solutions over the whole range of composition at temperatures somewhat below their melting points, and it is of interest to inquire whether at sufficiently low temperatures separation into two phases occurs or whether (for mixtures of these simple proportions) a super-lattice might be formed. If the energy w gained in mixing an AB pair, equal to $w_{AB} - \frac{1}{2}(w_{AA} + w_{BB})$ in the usual notation, is positive, separation into phases would be expected. If w is negative a super-lattice could be formed. Examination of this system might therefore provide sensitive information about the interatomic potential functions for argon and krypton.

In order to obtain an estimate of the temperature at which two phases or a super-lattice might appear, we may consider the van der Waals attractive potential only and neglect differences of size. The polarizability is then the chief factor of difference between A and B , and w_{AB} would be approximately equal to $\sqrt{w_{AA}w_{BB}}$ so that $w > 0$. The same conclusion follows from the results of detailed calculations due to R. A. Buckingham. We should not expect it to be modified if the repulsive potential were taken into account, so that separation into phases would appear to be favoured. (Differences of size would presumably be expected to favour separation into phases as opposed to the formation of a

super-lattice.) Making use of the known heats of sublimation, we estimate that w might be about 40 cal./mole, so that separation into phases might be expected somewhere between 10^5 and 40^5 K.

Careful measurement of the specific heat of the 1:1 mixture between 10° and 90° K. shows no discontinuity of any kind. The values lie intermediate between those reported by Clusius for pure solid argon and krypton respectively, but slightly above the mean values corresponding to any temperature. A redetermination of the values for the pure elements by Mr. Figgins now in progress suggests that C_p for the 1:1 mixture is equal to the mean of its values for argon and krypton within the limits of experimental error. Thus there appears to be no contribution to C_p from the disordering process, either in one or two phases. It is hoped that further information as to the state of order of the system will shortly be obtained by the use of X-rays. Meanwhile, it is of interest that Mr. R. Heastie (of Queen Mary College) has observed a positive deviation from ideality for solid solutions of argon and krypton, because such behaviour implies, for regular solutions, that w is greater than zero.

Prof. C. Domb gave a critical review of the methods of deriving information about intermolecular forces. There are three main sources of information: theoretical, gas data and solid-state data. Theory could provide a qualitative description of the form of the intermolecular potentials. At large distances the van der Waals attraction is represented by a series $-a/r^6 - b/r^8 - c/r^{10} \dots$ (Casimir and Polder have indicated¹ that the series should start with $1/r^7$, but the matter is not completely clarified.) At short distances the repulsive force is of the form $P(r) \exp(-\alpha r)$, where $P(r)$ is a polynomial. Detailed calculations are very complicated, however, and even for the simplest substance, helium, it is likely that estimates based on experimental data are more reliable than the famous Slater-Kirkwood potential².

In regard to the gaseous state, it is customary to make use of the second virial coefficient and transport properties. While the information thereby provided is valuable, it is not sufficient to determine the precise form of the intermolecular potential, and the repulsive portion is particularly uncertain.

More extensive information is provided by data on the solid state. The sublimation energy and equilibrium volume at the absolute zero are sufficient to dispose of two parameters in any proposed formula for intermolecular potentials. Further information is now becoming available as a result of the accurate measurements of elastic constants at Queen Mary College, and the accurate determination of Debye Θ values at low temperatures by R. W. Hill at Oxford. A recent series of measurements by Dr. C. A. Swenson at the Massachusetts Institute of Technology giving solid-state isotherms at pressures up to 4,000 atmospheres (I am indebted to Sir Francis Simon for providing me with these data) seems to open up the possibility of accurate information on the repulsive part of the intermolecular potential (these have recently been published: Stewart, J. W., *Phys. Rev.*, **97**, 578; 1955); this is being investigated by I. J. Zucker at King's College, London. Finally, the melting curve data at high pressures obtained at Oxford by Robinson and Simon clearly contain information about the repulsive potentials; but this can only be extracted if the Lindemann melting formula or some equivalent can be reliably established for high pressures.

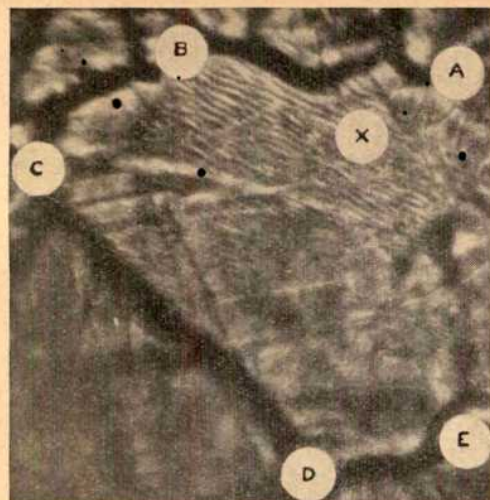


Fig. 1. Thermally etched surface of solid argon, showing a grain boundary *ABCDE* and striations, particularly in the region to the left of *X*. Magnification: the width of the photograph is approximately 3 mm.

In order to make effective use of the data on elastic constants, detailed calculations are required of the lattice dynamics of the face-centred cubic lattice, and this problem has been investigated recently by Barron and Domb³.

Dr. E. R. Dobbs presented an account of some measurements of the elastic properties of solid argon derived from a study of the velocities of sound in polycrystalline specimens. A preliminary investigation⁴ had shown that it was possible to obtain a compact, transparent solid of grain-size about 0.1 mm. by slowly depositing the argon from the vapour phase on to a surface cooled below the triple point (83.8° K.) of argon. This technique was used to grow a short cylinder of solid argon on one face of a gold-plated quartz crystal, one inch in diameter. The rate of growth was such that the solid argon increased in thickness by about 1 mm. every 10 min.

The quartz crystals used had an active area of about 2 cm. diameter and propagated continuously a plane wave of sound of wave-length (λ) in the solid argon of about 1 mm. This sound was reflected at a prepared flat solid/vapour interface and produced the usual resonance in the quartz crystal when standing waves arose in the argon. Accurate measurement of a number of positions of resonance, $\lambda/2$ apart, was achieved by stopping the growth of the argon when a resonance position had just been passed and then slowly cutting into the argon with a special tool the position of which was controlled by a micrometer screw.

The velocities of longitudinal (V_L) and of transverse (V_T) waves in solid argon were measured in this way to better than 2 per cent, using respectively 1 Mc./s. X-cut and 600 kc./s. Y-cut quartz crystals. These velocities, and an estimate⁴ of the density (Δ) of solid argon, enable the adiabatic compressibility (κ_s) and Poisson's ratio (σ) to be calculated. Using the specific-heat values of Clusius⁵, the isothermal compressibility (κ_T)

has also been computed. The results are given for three selected temperatures in the range covered by the experiments in the following table, where κ is in cm.² dyne⁻¹ units:

T (°K.)	Δ (gm./c.c.)	V_L (m./s.)	V_T (m./s.)	$\kappa_s \times 10^{10}$	$\kappa_T \times 10^{10}$	σ
60	1.63	1,410	770	0.51	0.53	0.29
70	1.62	1,380	735	0.52	0.55	0.30
80	1.61	1,305	705	0.60	0.65	0.30

Preliminary theoretical calculations give results in reasonable agreement with experiment³, but a more detailed investigation is being undertaken by T. H. K. Barron.

Dr. R. Followell described some recent experiments at Bristol designed to investigate the plastic properties of solid argon crystals.

The method of crystal growth, which was developed by Dr. D. Stansfield, is a modification of Bridgman's method in which a column of liquid is cooled slowly from one end, so that the solid-liquid interface moves gradually up the column. A growth-rate of 3-4 cm. an hour produces a polycrystalline specimen with an average grain-size of 2 mm., including grains of up to 6 mm. The specimen is grown in a rectangular tube with bulbous ends. The polycrystalline mass is detached from the walls of the specimen tube by judicious manipulation of temperature gradients.

Since the surface of the argon is then free, and at a temperature which is only of the order of 10° C. below the triple point of argon, thermal etching takes place and reveals the grain-boundaries, as shown by the line *ABCDE* in Fig. 1.

One of the objects of this research is to study the plastic properties of solid argon, including the phenomenon of slip. For this purpose the crystal is grown around a movable anchor, situated in one end of the specimen tube. The other end of the specimen is held by its bulbous end and so, by moving the anchor, tensile stresses may be applied to the central part of the specimen. An estimate of the strain is obtained by measuring the movement of the anchor. The observation of slip, however, was somewhat confused by the presence of thermally etched wavy striations caused by surface migration of the argon and shown in Fig. 1. In spite of this, slip has been unambiguously identified. Fig. 2*a* shows part of a grain one second before a stress was applied to the specimen, and Fig. 2*b* shows the same area five seconds after the stress was applied—a series of parallel straight lines are visible in Fig. 2*b* and must



Fig. 2. Part of the surface of a grain in solid argon (*a*) before and (*b*) after slip—the slip lines (left) are approximately vertical. Magnification: the width of the photograph is approximately 2 mm.

be slip lines, because the establishment of thermally etched striations takes considerably longer than six seconds.

Preliminary quantitative observations on the plastic properties of solid argon have included measurements of the ultimate stress as a function of temperature. The programme of future research includes a further study of the slip process, efforts to obtain single crystals, measurements of the creep-rate at liquid oxygen temperatures and below, a quantitative study of grain-boundary movements during grain growth and measurements of the elastic constants of solid argon.

C. DOMB

¹ Castmir, H. B. G., and Polder, D., *Phys. Rev.*, **73**, 360 (1948).

² Slater, J. C., and Kirkwood, J. G., *Phys. Rev.*, **37**, 682 (1931).

³ Barron, T. H. K., and Domb, C., *Phil. Mag.*, **45**, 654 (1954); *Proc. Roy. Soc., A*, **227**, 447 (1955).

⁴ Barker, J. R., Dobbs, E. R., and Jones, G. O., *Phil. Mag.*, **44**, 1182 (1953).

⁵ Clusius, K., and Weigand, K., *Z. phys. Chem.*, **B**, **46**, 1 (1940).

OBITUARIES

Sir Alexander Fleming, F.R.S.

SIR ALEXANDER FLEMING, the discoverer of penicillin, died suddenly on March 11 at his home in London with a heart attack at the age of seventy-three.

Alexander Fleming, the son of a farmer, was born near Darvel in Ayrshire, Scotland, on August 6, 1881. He received his early education at the village school and at Kilmarnock Academy. His father died when he was seven years old, and at thirteen years of age Alexander and his brother Robert were sent to live in London with a doctor brother who practised as an oculist in Marylebone Road. He continued his education for two or three years by attending the Polytechnic Institute in Regent Street, and then for four years worked in a shipping office. However, his doctor brother encouraged him to take up medicine, and with the help of a small legacy he became a student at St. Mary's Hospital Medical School, where he won the senior entrance scholarship in natural science. He showed that he had found his true bent by winning practically every class prize and scholarship during his student career. He qualified in 1906 and took his M.B., B.S. of the University of London in 1908 with honours and the gold medal.

In 1906 Fleming had begun to assist Almroth Wright in the Inoculation Department at St. Mary's Hospital, and he continued to work in the same Department for the rest of his life with the exception of an interlude during the First World War.

In 1928 he was appointed professor of bacteriology in the University of London, and he retired with the title of emeritus in 1948, but continued as the principal of the Wright-Fleming Institute of Microbiology until the end of last year. He was busily occupied with lecture tours and laboratory work to the end.

Fleming never ceased to pay tribute to the inspiring leadership of that great bacteriologist, Sir Almroth Wright, with whom he worked for nearly forty years. There is little doubt that in the early years he, like other assistants—and they were a distinguished team—was to a considerable extent the apprentice of Almroth Wright, whose dominant personality and fertile brain directed the general research programme of the Inoculation Department for many years. But even in the early days, Fleming showed

his ingenuity and originality in devising simple apparatus and techniques for tackling laboratory problems. The First World War directed his attention to wound infection and its control; he was one of the first to show that most wounds become infected after admission to hospital. As Wright's disciple, he took an active part in the controversy on the physiological versus chemical treatment of wounds, and again his inventiveness in devising apparatus and experiments to test the validity of a hypothesis or statement was very well demonstrated. This work led on to one of his classical experiments, in which he showed that carbolic acid when added to blood in certain concentrations killed the leucocytes but not the pathogenic germs, so that the antiseptic actually helped rather than hindered bacterial multiplication.

In 1922 came the discovery of lysozyme. Following an observation that his own nasal secretion after a common cold had an inhibitory action on some of the bacteria present in the nose, he showed that this lytic substance was present in many tissues and secretions of the body and was also widely distributed in Nature. But, because it was not particularly active against pathogenic organisms *in vitro*, the medical world did not give it the attention it deserved. His work with lysozyme prepared the way for the epoch-making discovery of penicillin.

Fleming had been studying variation in the staphylococcus, which meant that he was frequently examining colonies of that organism as they appeared on ordinary nutrient agar. As a result of this exposure, a mould appeared on the culture medium some days later and Fleming noticed the unusual phenomenon of the disappearance of staphylococcal colonies around the mould. His first paper describing his work with the active principle of this mould, which he named penicillin, shows that he appreciated the great potentialities of this substance as a new kind of antiseptic.

Fleming was a reticent and rather taciturn man, with great independence of mind and strength of character. He was a born naturalist, keenly observant of everything around him, and always ready to devise and test new methods for studying germs in the laboratory or seeds and plants in the garden. He accepted the many honours that were showered upon him with slightly amused modesty. The simple kind of tribute touched him most, such as a collection of signatures or a letter from a child or from some poor person who had benefited from penicillin. Freed from administrative duties, he had been looking forward to working again with his beloved phagocytes and lysozyme, for the natural defences of the body were his abiding interest; now, instead, we mourn the loss of a great scientist.

ROBERT CRICKSHANK

Prof. A. L. Dixon, F.R.S.

ARTHUR LEE DIXON died at Folkestone on February 20 at the age of eighty-seven. He was the son of the Rev. G. T. Dixon, Wesleyan minister of Northallerton, and was educated at Kingswood School, Bath. He was a scholar of Worcester College, Oxford, and his long and distinguished career is summarized in the appointments he held: in 1891 prize Fellow of Merton, in 1898 tutorial Fellow of that college, in 1922 Waynflete professor of pure mathematics and professorial Fellow of Magdalen

College, Oxford. He was elected to the Royal Society in 1912 and was president of the London Mathematical Society in 1924-25.

In 1945, on his voluntary retirement from the Waynflete professorship (for his was a pre-commission appointment), he was elected by Magdalen College to a supernumerary non-stipendiary fellowship, an appointment but rarely made and a very great tribute to Dixon's personal quality: colleges do not lightly award fellowships, with rooms and dining rights, to retiring professors in their late seventies.

Dixon's research career as a mathematician was long and varied. He wrote on algebra, algebraic geometry, pure geometry and elliptic functions; then, beginning a seven-year series when he was sixty-two years of age, published papers in collaboration with the present writer on Bessel functions and summation formulæ. He was no believer in compelling

every promising young man to embark on research: he was himself an example of how a man must carry out research if his mind is made that way.

Dixon's physical prowess and accuracy of eye were unusual, especially in the way he retained them to a late stage of his career; when he was nearly seventy it was not easy to beat him at squash, and even with seventy behind him he could still normally defeat several of his younger colleagues. But it is not for his hockey, tennis, squash or croquet skill that one admires Dixon most; nor even his musical knowledge and skill, nor yet his facility in foreign tongues: the thing about him that one recalls first and admires most is the slightly old-world courtesy and charm that permeated his every social contact. It was as completely natural to him as his physical strength or his mathematical power: it endeared him to many friends and made him a welcome visitor wherever he went.

W. L. FERRAR

NEWS and VIEWS

Glass Technology at Sheffield :

Prof. Harry Moore

PROF. HARRY MOORE, who is retiring from the chair of glass technology in the University of Sheffield, began his career in the University of London as a lecturer in physics. During this time he studied the effects of homogeneous X-radiation on a variety of materials and also wrote (with H. S. Allen) his "Textbook of Practical Physics", which was followed later by the "Textbook of Intermediate Physics". After the First World War he was appointed assistant director (later director) of research of the British Scientific Instrument Research Association, where he was able to use to the full his capabilities as an administrator and leader of a powerful research team. Prof. Moore had long been interested in glass, and the invitation, which he accepted in 1937, to become director of research for Messrs. Pilkington Bros., Ltd., enabled him to turn his attention to the many problems of modern, large-scale glass manufacture. In 1945 he went to Sheffield in succession to Prof. W. E. S. Turner. He was president of the Society of Glass Technology in that and the previous year. His recent work has been primarily concerned with the colouring and decolorizing of glass in relation to its structure. He has conducted spectrophotometric studies and also investigations into the magnetic and electrical properties of glasses, all of which have provided valuable information on the role of iron in colouring glasses. Internationally known for his work in glass technology, Prof. Moore is particularly distinguished for his capabilities as a lecturer; his ability to explain intricate problems in lucid terms has delighted many audiences.

Prof. R. W. Douglas

PROF. MOORE is being succeeded by Mr. R. W. Douglas, who has pursued his scientific career as a member of the G.E.C. Research Laboratories, which he joined in 1927. After some early work on the measurement of the physical properties of glass, he became concerned with more fundamental problems such as the relation between the physical properties and basic structure of glass and the similarity in

behaviour between glass and the liquid phase in respect of such properties as density, thermal expansion and viscosity. He is now well known as an authority on the physics of glass, and his many publications on the subject have enriched the literature in this field. From about 1946, Mr. Douglas extended his activities to include participation in the field of semiconductor physics. A primary concern with the semiconductor materials themselves and their physical properties led to an interest in the physics of the solid state generally. Among the projects for which he has been responsible have been the development of new semiconducting materials and the elucidation of the properties of semiconductors on the grounds of both theory and experiment. In recent years, Mr. Douglas has contributed to several international meetings concerned with the physics of semiconductors. In spite of this later change in his activities, Mr. Douglas has retained his interest throughout in all matters concerned with glass technology and the physics of glass. He has served on technical committees of the Society of Glass Technology and since 1949 has been honorary secretary of that Society.

British Glass Industry Research Association

A NEW research association, the British Glass Industry Research Association, has been formed and has started work at "Elmfield", Northumberland Road, Sheffield, with Dr. R. G. Newton as director of research, and Dr. D. K. Hill as assistant director. Unlike other newly formed research associations, this one does not have to inaugurate its research, for it will take over from the Department of Glass Technology of the University of Sheffield and will thus continue the tradition of research work begun there during the First World War. During the past few years it has become evident that the demands from industry on the time of the professor at Sheffield have become so great that it is essential to divide the work previously carried out into two portions: a University teaching department, which will also carry out research; and a research association which will carry out all the functions for industry of consultation and remedying troubles, together with research for industry. The new arrangements have

now been made, and the British Glass Industry Research Association and the Department of Glass Technology are separately administered, although they share the same University buildings at "Elmfield". For the Research Association, industry will subscribe a minimum of £20,000, while the Department of Scientific and Industrial Research will grant £10,000 a year with an extra £100 for each £100 that industry subscribes above the minimum. On the University side, the University sources will provide the bulk of the money required to run the Department of Glass Technology, but manufacturers have undertaken to continue to give financial support to the Department worthy of its position as a source of well-equipped scientific and technological personnel.

Dr. R. G. Newton

THE new director of research of the British Glass Industry Research Association, Dr. R. G. Newton, who was born in 1912, took his Ph.D. and D.I.C. for botanical work at the Imperial College of Science and Technology, London, and later worked on the physiology of latex for the Rubber Growers' Association. He entered the Research Association of the British Rubber Manufacturers in 1938 as a research assistant and was appointed head of the Research Division in June 1940. After the Second World War, Dr. Newton's work was particularly associated with the use of modern statistical methods in research analysis. Towards the end of 1948 he joined the British Rubber Producers' Research Association and two years later was appointed co-ordinating officer for technically classified rubber, on behalf of the International Rubber Research Board. This involved general co-ordination of new development and the producers' interests, and his responsibility for general liaison between producers and consumers resulted in wide travelling in Malaya, Indo-China, Indonesia and the United States. In July 1953 he was appointed deputy secretary of the International Rubber Research Board and the International Rubber Development Committee, and continued to co-ordinate the international aspects of technically classified rubber. The work on which Dr. Newton will be engaged is in an entirely new field; but he will carry with him a wide administrative experience formed from his work with two important research associations.

Civil Engineering at Sheffield : Prof. N. S. Boulton

SINCE 1936 the three University Departments of Mechanical, Civil and Electrical Engineering of the University of Sheffield have been under one professor of engineering, each Department being directed by a senior lecturer. Separate chairs of civil engineering and electrical engineering have recently been created, and Mr. N. S. Boulton, senior lecturer in charge of the Department of Civil Engineering, has been appointed to the newly created chair in that Department. Mr. Boulton is a graduate in civil engineering in the University of Birmingham; he remained at Birmingham for a further two years carrying out research, for which he was awarded the degree of M.Sc. and the Dudley Docker Research Scholarship. After five years professional experience in the Public Works Department of the City of Birmingham, and seven years lecturing experience at King's College, Newcastle upon Tyne, in 1936 he was appointed senior lecturer in charge of the Department of Civil Engineering at Sheffield, and is now deputy dean of the Faculty of Engineering. Prof. Boulton is the

author of several papers in the field of hydraulic flow, plasticity and stress analysis.

Director of Experimental Centres of the National Agricultural Advisory Service

THE Ministry of Agriculture and Fisheries has recently announced the creation of a new post in the National Agricultural Advisory Service, namely, that of director of experimental centres, and Mr. P. J. Macfarlan, at present deputy provincial director for the Yorkshire and Lancashire Province, has been appointed to fill it. The post is graded at the level of provincial director, and the holder will work at the headquarters of the Service in London. The principal duty of the director of experimental centres will be to supervise and control the experimental work at the experimental husbandry and horticulture centres, and thus he will do under the direction of the senior advisory officers and in close association with the Experimental Husbandry and Experimental Horticulture Committees (and Sub-Committees) of the Agricultural Improvement Council, to which he will act as convenor. His duties will also include the general supervision and co-ordination of the field experimental work at provincial centres and in the counties, and responsibility for the collection, tabulation, examination and preparation for publication of the results of experiments.

The Parliamentary and Scientific Committee: Report for 1954

THE annual report for 1954 of the Parliamentary and Scientific Committee (pp. 24; from the Committee, London; 1955), besides the usual list of subscribing members and brief report of the annual general meeting, gives a list of addresses and discussions before the Committee during the year, most of which have already been noted in *Nature*. It includes also a summary of the report of the sub-committee on higher technological education and of the main points made by the Lord President of the Council in a House of Lords debate on the subject. At a meeting of the Committee on December 7, it was agreed that the sub-committee should be maintained in being to advise what further recommendations should be made to the Government with regard to the implementation of the plans outlined by the Lord President. Several members of the Committee specially supported the President of the Board of Trade in the second reading of the Development of Inventions Bill on January 26, 1954. During the year a small sub-committee was set up, with Sir Harold Roper as chairman, to consider whether any action was called for in connexion with the report of the Faulkner Committee on the Prevention of Pollution of the Sea by Oil. As a result of several meetings and consultations with experts, a resolution was submitted to, and passed by, the Parliamentary and Scientific Committee, recommending that the Lord President of the Council should, in consultation with the Minister of Transport and other Ministers concerned, arrange for the early appointment of a small committee to ensure that all necessary research work relating to the pollution of the sea by oil is put in hand forthwith and co-ordinated with any relevant current research work, and suitable arrangements made for its implementation. It is understood that the Oil Pollution Committee afterwards set up by the Government is taking special steps to deal with the various aspects of research involved, and its chairman has informed Sir Harold Roper that the

Committee is in broad agreement with the Parliamentary and Scientific Committee's recommendations as to matters for further research. Questions of fuel efficiency and the building programme of the Department of Scientific and Industrial Research were also raised in Parliament during the year.

Society for Analytical Chemistry

The eighty-first annual general meeting of the Society for Analytical Chemistry was held in London on March 4, when the financial statement and the report of the Council for the past year were submitted and approved. The membership of the Society was reported as being 1,799—an increase of 153 since last year. In addition to five ordinary meetings in London (two of which were organized by the Biological Methods Group and one by the Microchemistry Group), a joint meeting with the Oils and Fats Group of the Society of Chemical Industry, and twenty-one meetings held by the Society's various Sections and Groups, the Society organized two special meetings in London as follows: one on the use of perchloric acid in analytical chemistry, at which a paper was read by Prof. Harold Burton and Dr. P. F. G. Prail, and one by Prof. G. Frederick Smith (University of Illinois); and the other, at which Prof. G. Schwarzenbach (University of Zurich) spoke on the complexones and their analytical applications, and Dr. H. M. N. H. Irving gave demonstrations.

At the annual general meeting of the Society the following officers and members of Council were elected for the forthcoming year: *President*, K. A. Williams; *Past Presidents serving on the Council*, Lewis Eynon, D. W. Kent-Jones, J. R. Nicholls and George Taylor; *Vice-Presidents*, C. A. Adams, D. C. Garratt and H. M. N. H. Irving; *Honorary Treasurer*, J. H. Hamence; *Honorary Secretary*, N. L. Allport; *Other Members of Council*, D. C. M. Adamson, C. H. R. Gentry, J. Haslam, C. L. Hinton, W. C. Johnson, A. G. J. Lipscomb, T. McLachlan, R. F. Milton, Miss Mamie Olliver, S. A. Price, R. E. Stuckey and C. Whalley; *Ex-officio Members*, J. R. Walmsley (chairman, North of England Section), F. J. Elliott (chairman, Scottish Section), H. J. Evans (chairman, Western Section), J. R. Leech (chairman, Midlands Section), G. F. Hodsman (chairman, Microchemistry Group), A. A. Smales (chairman, Physical Methods Group) and L. J. Harris (chairman, Biological Methods Group).

Models of Molecular Structure

MANY research workers have been aware of the value of the space-filling atomic models developed by G. S. Hartley and C. Robinson at the Maidenhead Laboratory of Courtaulds, Ltd. These models are now available commercially from the firm of Griffin and Tatlock (Kemble Street, Kingsway, London, W.C.2). Primarily designed for research, where accurately made models are required from which quantitative deductions of molecular geometry can be made, the models are also eminently suitable for lecturing purposes. Their large size (scale 0.8 in. to 1 Å.) and comparative 'transparency' make even complicated structures easy to follow. The bond angles, covalent radii and van der Waals radii of the atom models are based on currently accepted values. When the arrangement involves only δ -bonds the models are designed by cutting back spheres, of radii equal to the van der Waals radii, in the direction of each valency bond, by an amount which leaves the

distance from the atom centre to the middle of the link equal to the appropriate covalent radius. For those atoms forming bonds involving π -electrons, the van der Waals radius will be longer in a direction normal to the bonds as a consequence of the π -electron orbitals. Account has been taken of this factor. A notable feature of the design is the arrangement of brass link and rubber collar by which the models are joined together. This provides elastically distortable valency angles so that many molecules can be built, including those with strained rings, which cannot be constructed with a rigid linking mechanism. At the same time there is no sacrifice of free rotation about single bonds, while large molecules can be handled without falling apart. Important contributions to peptide and protein chemistry have already been made with the aid of these models. It is likely that their application in other fields will be equally fruitful.

Indian Council of Ecological Research

IN order to promote and expand ecological studies on Indian vegetation, an Indian Council of Ecological Research has recently been set up and will hold its first meeting at the Forest Research Institute, Dehra Dun, later this year, when plans will be made for the execution of ecological studies in relation to forestry, agriculture, desert control, soil conservation, flood control, etc. The heads of forest departments of all States of the Union and vice-chancellors of all Indian universities have been requested to send a note describing the type of ecological research at present being conducted and whether they will be able to participate in the work of the Council. With the information so collected, the Council will select places for the setting up of small experimental stations for ecological research in collaboration with a particular university or State forest and agricultural departments. The Council also expects to arrange at Dehra Dun a short course in techniques and methods in ecological research for students, teachers and other workers engaged in ecological research. The Council consists of the following officers together with twelve members: *Chairman*, Shri C. R. Ranganathan, inspector-general of forests, New Delhi; *Vice-Chairmen*, Shri K. L. Aggarwal, president of the Forest Research Institute and Colleges, Dehra Dun; and Father Santapau, chief botanist, Botanical Survey of India, Calcutta; *Secretary*, Dr. G. S. Puri, ecologist, Forest Research Institute, Dehra Dun. All inquiries should be directed to the secretary at P.O. New Forest, Dehra Dun, U.P.

Pectic Enzymes

IN a further contribution to the physiology of parasitism, R. K. S. Wood (*Ann. Bot.*, N.S., 19, 1; 1955) has investigated the pectic enzymes secreted by *Bacterium aroideae*. He has shown that cell-free filtrates from cultures of this organism on a simple synthetic medium contained an enzyme, that he has provisionally called 'depolymerase', which has the property of reducing rapidly the viscosity of pectin solutions. The filtrate also contained protopectinase which macerated slices of potato tuber. The filtrates, however, had little pectin-esterase activity. The activity of the depolymerase was found to be directly proportional to the enzyme concentration; that of the protopectinase was approximately proportional to the square root of the enzyme concentration. Partial purification of crude solutions was effected by acetone or ethanol precipitation. The various

properties of the enzyme preparations and of the depolymerase have been investigated and results recorded. The differences between the pectic enzymes of *B. arborescens* and those from other sources, and the possible identity of depolymerase, polygalacturonase and protopectinase, are discussed.

Symbiotic Systems for Nitrogen Fixation

G. Bond and G. D. Scott have been able to demonstrate, by using nitrogen-15, the occurrence of fixation of elemental nitrogen in the lichens *Collema granosum* and *Leptogium lichenoides*, in both of which *Nostoc* is present as the algal component (*Ann. Bot.*, N.S., 19, 65; 1955). A similar result has been demonstrated in the liverwort *Blasia pusilla* in which *Nostoc* is present in thallus cavities. The indications are that *Nostoc* is the agent responsible for the nitrogen fixation. In the same investigation, no evidence was obtained of nitrogen fixation on the mycorrhizal roots of intact plants of *Calluna vulgaris* or of *Pinus sylvestris*, both of which, but especially the former, have been held by previous investigators to be capable of nitrogen fixation.

Zoological Nomenclature

NOTICE is hereby given that, as from August 28, 1955, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of the plenary powers for the purposes specified against each entry. Full particulars of these cases were published on February 28, 1955, in Parts 3 and 4 of Vol. 11 of the *Bulletin of Zoological Nomenclature*. (1) *Entomobrya Rondani*, 1861 (Cl. Insecta, Order Collembola), validation of; (2) *Iphis* Leach, 1817 (Cl. Crustacea, Order Decapoda), validation of (correction of error in Opinion 73); (3) *Homalaspis* Milne Edwards (A.), 1863 (Cl. Crustacea, Order Decapoda), validation of (correction of error in Opinion 85); (4) *Monticulipora* d'Orbigny, 1849 (Cl. Bryozoa), designation of type species for; (5) *obscura* Berezowsky and Bianchi, 1891 (*Larvivora*) (Cl. Aves), validation of; (6) *bei* Ridgway, 1874 (*Eremophila alpestris* var.), suppression of; (7) *dingo* Meyer, 1793 (*Canis*) (Cl. Mammalia), validation of, as the name for the dingo; (8) *Bombina* Oken, 1816 (Cl. Amphibia, Order Anura), conservation of; (9) *Scolopendra* Linnaeus, 1758 (Cl. Myriapoda), designation of type species for. Proposals are also made for the adoption of two 'Declarations': (a) clarifying Rule (g) of Article 30, relating to the selection of the type species, in cases where a species has two or more names objectively synonymous with one another; (b) regarding the specific name to be adopted for the type species of a genus in cases where that species possesses two or more objectively synonymous such names. Comments should be sent as soon as possible to Francis Hemming, secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

Biochemical Periodicals in Poland

THE successful reorganization of teaching and research activities in Polish biochemistry is well illustrated by the publication of no fewer than three new journals sponsored by the Polish Academy of Sciences in Warsaw, and devoted largely to biochemistry. *Postępy Biochemii* (*Progress in Biochemistry*) is edited by Prof. J. Heller, and consists of review-articles based on symposia organized periodically by the Biochemical Committee of the Academy. The latest issue (No. 2) reports on two

such symposia, one on clinical biochemistry, with contributions by W. Mozolowski and Z. Stelzmann, among others; the other on plant biochemistry and chemical mycology. *Acta Biochimica Polonica* is a quarterly, devoted entirely to original papers, written in Polish, but with extensive summaries in both Russian and English. Volume 1 includes among its thirteen papers several original contributions on blood biochemistry (including one by Skarzynski and another one by Mozolowski) as well as some extensive analytical studies on purine bases by Dmochowski. *Bulletin de l'Académie Polonaise des Sciences, Classe Deuxième*, covers the whole field of biological and medical sciences and consists of papers communicated by members of the Academy. A recent issue (Vol. 2, No. 2) contains ten papers (all in English), of which three are biochemical, one by Galos and Ostrowski on the electrophoretic separation of carbohydrates, another by Zakrzewski *et al.* on physicochemical properties of dextran, and a third by Shugar and Syrczek on lysozyme, mainly on the kinetics of its inactivation by heat.

Van de Graaff Generator at the Weizmann Institute of Science, Rehovoth

A 3-MV. Van de Graaff positive-ion accelerator is being constructed specially for the Weizmann Institute of Science, Rehovoth, Israel, by the High Voltage Engineering Corporation of Cambridge, Mass., and, when installed, will be used at the Institute for studying nuclear reactions produced by the bombardment of the nuclei with high-energy protons. Dr. Gvirol Goldring, of the Weizmann Institute's Department of Nuclear Physics, is going to the United States, where he will take part in the construction of the Van de Graaff generator and be responsible later for its assembly, installation and operation at Rehovoth. He will spend some time at the Massachusetts Institute of Technology making himself familiar with the details of a similar generator already installed there. The new generator is due to be completed in the United States in December 1956 and to be installed in the new building of the Nuclear Physics Department at the Weizmann Institute in May 1957. Work on the building is scheduled to begin later this year as part of the Yad Chaim Weizmann programme of scientific and cultural development. On his way to the United States, Dr. Goldring, who is twenty-seven years old, is spending a month in France at the University of Strasbourg, where he has been invited by the Physics Department there to assist in drawing up an advanced programme connected with the Van de Graaff accelerator recently acquired by it.

Wool Textile Research Conference in Australia

A NUMBER of scientific workers of international reputation in wool research and related fields of study have been invited to attend a research conference on wool textiles, to be held in Australia during August-September under the auspices of the Commonwealth Scientific and Industrial Research Organization. Besides giving them the opportunity to discuss the latest developments in their particular topics, the conference will also enable members to see the advances that have been made in Australian research laboratories and to make contacts with Australian research workers. The members will be able to visit the C.S.I.R.O. wool textile research laboratories, which are situated in three of the principal Australian wool-manufacturing centres and comprise a big-

logical chemistry laboratory in Melbourne, known as the Biochemistry Unit, the Physics and Engineering Unit in Sydney, and a Unit at Geelong studying wool textile processing. In addition, the Gordon Institute of Technology at Geelong and the recently established New South Wales University of Technology in Sydney have extensive facilities for wool textile research, and also the C.S.I.R.O. Division of Industrial Chemistry in Melbourne has for some years carried out investigations into the structure of proteins and the chemistry of wool wax. The conference will open in Sydney on the morning of August 22, and on August 26 the delegates will leave by road for Geelong, where sessions will be continued during August 31–September 2; the final sessions will be held in Melbourne during September 5–9. The programme will be in three parts: the chemistry and biochemistry of proteins (the structure information can be obtained from the Secretary, of keratin and the wool fibre); wool physics and fibre assemblies; and wool technology. Further International Wool Textile Research Conference, c/o C.S.I.R.O. Wool Textile Research Laboratory, 343 Royal Parade, Parkville, N.2, Victoria, or from the C.S.I.R.O. liaison offices in London and Washington.

Announcements

THE spring conference of the Scientific and Technical Group of the Royal Photographic Society is being held at Reading on April 30. The detailed programme can be obtained from R. E. Withrington, 49 Kensington Avenue, Manor Park, London, E.12.

THE Scottish Field Studies Association is arranging a conference on "Field Studies in Education", to be held in Glasgow on April 25, in Aberdeen on April 26 and in Edinburgh on April 27, with the proceedings commencing each day at 4.30 p.m. The opening address will be given by Mr. F. H. C. Butler, founder and educational adviser of the Council for the Promotion of Field Studies. The conference is especially for those professionally concerned with education and is designed to emphasize the need for field studies in education in Scotland. Further information can be obtained from the Honorary Secretary, Scottish Field Studies Association, Department of Botany, University, Glasgow, W.2.

THE British Society of Rheology is holding a conference on "Visco-elastic Behaviour" in the Physics Department, King's College (University of Durham), Newcastle upon Tyne, during April 29–30. An exhibition of rheological apparatus is being arranged in conjunction with the conference. Further information can be obtained from Dr. E. G. Richardson, King's College, Newcastle upon Tyne.

THE fifth conference of the International Society for the Study of Biological Rhythm will be held in the Department of Anatomy of the Caroline Institute, Stockholm, during September 15–17. The principal themes will be rhythmical phenomena in the nervous system; cybernetics; and rhythm and industrial medicine. Further information can be obtained from Prof. Ture Petré, Karolinska Institutet, Stockholm 60.

A SHORT course in chemistry for teachers from technical colleges, to be held at Wynyard Hall Training College, Wolviston, Billingham, County Durham, during July 18–27, is being arranged by the Ministry of Education. The course will be concerned with the chemical and other aspects of large-scale

chemical manufacturing operations, with particular reference to the processes at the Billingham and Wilton works of Imperial Chemical Industries, Ltd. The fee for the course, which is residential, is £11. Applications, to be made on Form 106 RSC, must be sent in by April 30. Further information can be obtained from the Ministry of Education, Teachers Short Courses, 36–38 Berkeley Square, London, W.1.

THE Edinburgh Mathematical Society is holding its annual colloquium in St. Andrews during July 13–23. The colloquium will consist of several short-invited courses of lectures on topics of general interest to mathematicians, supplemented by a number of single lectures, most of which will be on more specialized subjects. The following will be lecturing: M. F. Atiyah (Cambridge), Prof. P. Hall (Cambridge), Prof. W. W. Rogosinski (Newcastle), Prof. E. Stiefel (Zurich), and Prof. J. L. Synge (Dublin). The fee for the course is 10 guineas (non-residents £1 12s. 6d.). Further information can be obtained from the colloquium secretary, Mr. J. R. Gray, United College, St. Andrews.

A COURSE on "Biology and Civil Engineering", to be held in London during July 3–16, has been planned for overseas civil engineers by the British Council in co-operation with the Institution of Civil Engineers, with the object of imparting some of the recent developments which have taken place in Britain in the application of biological research to engineering problems. The programme is designed to be of particular interest to those specializing in water supply, sewage treatment, the control of pests, the preservation of timber and the effect of vegetation on structures. The fee for the course, which is fully residential, is £40. Applications should be made to the local British Council representative or to the Director, Courses Department, British Council, 65 Davies Street, London, W.1.

THE Industrial Research Committee of the Federation of British Industries has organized a conference on "The Education and Training of Graduate Staff for Industrial Research", to be held at Ashorne Hill, near Leamington, during April 29–May 1. The speakers will include Sir Edward Bullard, director of the National Physical Laboratory; Prof. E. G. Cox, professor of inorganic and structural chemistry in the University of Leeds; Prof. J. A. Pope, head of the Departments of Civil and Mechanical Engineering in the University of Nottingham (first degree courses); Mr. C. Paine, director of Imperial Chemical Industries, Ltd.; Mr. O. W. Humphreys, director in charge of research, General Electric Co., Ltd. (selection and training); Prof. H. W. Melville, Mason professor of chemistry in the University of Birmingham; and Prof. A. J. S. Pippard, professor of civil engineering, Imperial College of Science and Technology, University of London (postgraduate training). Particulars can be obtained from Mr. G. Withers, Federation of British Industries, 21 Tothill Street, London, S.W.1.

A RESEARCH scholarship worth £400 a year for two years is being offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects, and it is hoped to make an award in September. Further particulars of entry, which closes on June 30, can be obtained from the Secretary of the Institution, 10 Upper Belgrave Street, London, S.W.1.

RESEARCH IN TECHNICAL COLLEGES

By DR. F. HAPPEY

Head of the Department of Textile Industries, Bradford Technical College

THE question of the status of higher technology is a matter which has been exercising all levels of critical opinion in Britain. In all cases, however, it has been generally agreed that little progress in higher technological education can be made except it be in an institution which itself encourages technological research and development in the appropriate departments. In this field it is of interest to consider the progress in research which has been made in the Textile Department in the Bradford Technical College and some of the difficulties which have still to be faced in this work.

The Wool Textile Research Council was formed some years ago as a committee representative of the industry to collect a statutory levy from the wool industry and dispense the funds among the Wool Industries Research Association, the universities and the major technical colleges of the wool areas of Great Britain. Bradford Technical College draws a considerable sum of money from this body every six months, and together with other grants and scholarships from the City of Bradford, the International Wool Secretariat, the Rayon Research Federation, the Bradford Dyers' Association, Woolcombers, Ltd., and the local Hospital Management Committee, etc., has been able to draw up a wide and comprehensive research programme. This work is partially technological, that is, research and development work on spinning, weaving and designing is in progress, and also a scientific programme has been inaugurated dealing mainly with fibre structure and the growth and development of wool and other related tissues.

A team of research workers in the Department of Textile Industries has been collected during the past three years, and attempts have been made to recruit research Fellows and Scholars from as wide a field of training as possible. It is obvious that this is the best way to broaden the scope of the work and the outlook of the research student during and after his training period. To this end, during the past three years, a staff has been recruited as follows. (These include four members of the research teams who are carrying out work in the Department of Chemistry and Dyeing, and who, with other research workers outside the scope of this discussion, are under the general direction of Dr. R. L. Elliott, head of that Department): (a) four Research Fellows, from the Universities of Oxford, Manchester, Sheffield and London (Bradford external student); (b) eleven Research Scholars for scientific research, from Manchester, Sheffield, Liverpool, London (internal) and London (external); (c) five Research Scholars for technological research—one internal London graduate and four past diploma students of the Textile Department of the Technical College.

It is clear from the list of research workers, whose remunerations vary between £300 and £900 (approximately) a year, that the industry and local authority have carried out their commitments to the full and with a considerable sense of urgency. In point of fact, the specialized equipment is provided mainly by the Wool Textile Research Council, although it must be clearly understood that from the point of view of development work the education authority has during

the past provided a complete range of pilot plants so that trials can be carried out in a routine manner in the spinning, manufacturing and finishing sheds of the Department. Thus, even before its expansion the Textile Department has had adequate equipment for certain of its anticipated research and development work. When, however, one considers the academic awards available to the students, the situation can at its best be described as chaotic and at its worst, farcical.

First, there is no fundamental difficulty for London graduates in submitting work for higher degrees. Secondly, in the case of non-London graduates, those from the civic universities can submit work for M.Sc., but are not acceptable to these institutions as Ph.D. students. In this way they are no more favourably placed than graduates working in industry, so that research in technical institutes with scholarship finance is only likely to attract a core of enthusiasts. The graduates from the older universities are in an even less enviable position; there is no research degree which they can attain.

Finally, for the diploma students the outlook is no more encouraging. All the students mentioned earlier with the primary qualification are eligible for the direct award of associateship of the Textile Institute two years after obtaining the diploma and when they reach the age of twenty-five years. Three of these students have already carried out sufficient research to submit the work for the award of fellowship of the Institute, essentially a research qualification, but the latter diploma cannot be held for some years after the student has been awarded the associateship qualification. (I am not in disagreement with the principle of the award of the associateship at twenty-five and fellowship at thirty (approximately), as many factors other than academic ability are involved in all such professional awards.) Thus, academically, students may well be of fellowship standard before they have reached the age barrier of associateship. Unfortunately, there is no award whatsoever which can give these technological research workers an academic designation of the standard which they have attained.

From the academic point of view, therefore, the provision of appropriate degrees is the final stage in the establishment of a school of textile research in Bradford Technical College. The standard of research work and the theses submitted by the research students of the College have been of a sufficiently high standard that up to the present no application for a higher degree has been rejected by the external examining bodies, from which it is reasonable to assume that the work is of an adequate standard. One might therefore ask, what is the difficulty?

No longer can the blame for the inadequate provision of opportunity be laid at the door of the City or the industry; it now appears to rest firmly on the shoulders of these bodies whose terms of reference include the authorization and institution of scientific and technical degrees and diplomas. I have directed attention to these anomalies and difficulties with some diffidence.

SMITHSONIAN INSTITUTION

ANNUAL REPORT FOR 1953-54

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1954*, refers to the completion of a new exhibition hall, opened to the public on April 14, 1954, as the first installation of the programme of modernization and reconditioning of exhibitions in the Institution which during the next nine years should transform entirely the outmoded, inadequate and sometimes uninstruc-tive features of the Smithsonian exhibitions so that they can be seen in a modern suitable setting. This first hall displays the development of the archaeology of Central and South America before the coming of Columbus. Much progress was made during the year in developing detailed specifications for the new Museum of History and Technology, and further consideration has also been given to the buildings required for the National Zoological Park and the Natural History Building. The River Basin Pro-gramme was sharply curtailed, and the Secretary expresses anxiety lest, if funds are not made available next year, it will be forever too late to pursue the study of the early life of the original Americans, 80 per cent of whose important archaeological remains are in river basins.

For further details of these surveys, the Secretary refers to the report of the Bureau of American Ethnology; this latter report and those of the other nine bureaux administered by the Institution, of the library, of the executive committee of the Board of Regents, and that on publications are appended. During the year 632,243 specimens were added to the collections in the United States National Museum, visitors to which numbered 3,262,150, and in which on an average at least a hundred scientists not on the Smithsonian staff are daily at work. Field-work was conducted in Thailand, Venezuela, Panama, the Caroline Islands, Fiji, Mexico, and many parts of the United States. Dr. M. W. Stirling, director of the Bureau of American Ethnology, continued his studies of Panamanian archaeology, and Dr. H. B. Collins his Eskimo research and other arctic activities, including chairmanship of the committee supervising the preparation of the "Arctic Bibliography" for the Department of Defense. Studies of Olmec archaeol-ogical materials from southern Mexico were con-tinued by Dr. P. Drucker, while field activities in the river basin surveys consisted chiefly of reconnaissance or surveys to locate sites that will be involved in construction work or eventually submerged by reservoirs. By June 30, 1954, archaeological surveys or excavations had been made since 1946 in 243 areas in 27 States and 4,345 archaeological sites recorded, of which 852 were recommended for excavation or further testing. Activities of the Missouri Basin project were greatly reduced for lack of funds, but six field parties operated in the Basin during the year. In Tennessee detailed surveys were made of the Cheatham Lock and Dam and Old Hickory Lock and Dam projects on the Cumberland River near Nashville.

The Astrophysical Observatory completed work on the ninth revised edition of the "Smithsonian Physical Tables" and on Vol. 7 of the "Annals of the Astro-physical Observatory". Solar-radiation studies were

* Smithsonian Institution. Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1954. (Smithsonian Publication 4182.) Pp. ix+175+4 plates. Washington, D.C.: Government Printing Office, 1955.)

continued at Table Mountain, California, and Mount Montezuma, in Chile; and besides routine work, calibrations were made of a silver-disk pyroheliometer for the Meteorological Service of Canada, a modified Ångström pyroheliometer for the Meteorological Service of the Belgian Congo, and a normal-incidence Eppley pyroheliometer for the United States Weather Bureau. The Division of Radiation and Organisms has shown that the apical stem hook is an excellent and reproducible test object for measuring the effect of radiant energy and chemical factors in the photo-morphogenic response, and that triiodobenzoic acid, which opposes the effect of auxin in many other plant responses, produces an effect on the bean stem hook similar to that of the photo-reaction; studies have been completed of the effectiveness of various wave-lengths on the opening of the bean hook.

Progress was made in transport of the stored collections of the National Air Museum from Park Ridge, Illinois, to improved conditions at Suitland, Maryland, and three hundred and sixty specimens were added during the year. A special exhibit was arranged in December 1953 in connexion with the celebration of the fiftieth anniversary of powered flight, while the Museum's studies of the origin and history of the guided missile in the United States and of the pictorial history of the Wright brothers were materially advanced. Accessions to the National Zoo-logical Park numbered 899 and visitors 3,616,220, but new buildings are urgently needed, as well as new paddocks. During the year twenty-two scientific workers went to the Canal Zone Biological Area for research, but the number of visitors decreased by a quarter.

The number of packages transmitted by the International Exchange Service decreased by 1,429 to 1,020,509; but 3,566 boxes, or 917 more than during 1952-53, were shipped to the foreign exchange bureaux, including sixty-two full sets and forty-three partial sets of United States government documents in exchange for official publications of foreign governments. Additions to the Library totalled 69,484 publications, and 515 new exchanges were arranged, while more than fifteen thousand reference questions were handled despite the fact that under-staffing kept the bureau libraries closed except to staff and that overcrowding in the library of the National Collection of Fine Arts urgently needs to be relieved.

VISCOSITY OF POLYMER SOLUTIONS

AS a continuation of two earlier seminars on polymer science (see *Nature*, 171, 65 (1953), and 172, 102 (1953)), four lectures on the viscosity of polymer solutions were given in the Chemistry Department of University College, London, on March 11. Short abstracts of the lectures were circulated in advance, and this facilitated the discussions which followed the lectures. Prof. P. J. Flory dealt with relationships between the volume taken up by a flexible chain-like polymer and the viscosity of solutions containing such species. In good solvents the polymer molecules expand, and in poorer ones they assume a more nearly statistically unperturbed configuration. Through the use of suitable viscosity measurements, it is possible to

establish the unperturbed dimensions of the polymer chain, which depend on bond-lengths and -angles and on hindrance to free rotation. The theory, developed by Flory, enables, furthermore, an estimation to be made of thermodynamic parameters related to the heat and entropy of dilution of the polymer in a given solvent. It is also possible to explain the marked alteration of the viscosity of polyelectrolyte solutions brought about by changes of pH or ionic strength.

Prof. C. E. H. Bawn discussed intrinsic viscosity relationships for polyisobutylene and polystyrene in mixed solvents, some of the intrinsic viscosities being determined over a range of temperatures. These results were used to examine existing theories of the viscosity of polymer solutions and, in particular, the relationships dealt with by Prof. Flory.

Prof. J. A. V. Butler gave an account of viscosity measurements of two polyelectrolyte solutions, these experiments being done at low concentrations and rates of shear. Some of the results were interpreted with the help of an electrostatic theory of charged thread-like particles. Dr. B. A. Toms described a rheological investigation of about 3 per cent solutions of polymethylmethacrylate. The experiments were carried out with the help of a coaxial cylinder elastoviscometer. The rheological behaviour of these solutions can be specified by a viscosity coefficient, a relaxation time and a retardation time. The variability of these parameters indicates that relaxation of shear and of rate of strain are effected by different mechanisms.

THE COUNCIL FOR THE PROMOTION OF FIELD STUDIES

AFTER a stringent period of economy caused by financial difficulties, the chairman of the Council for the Promotion of Field Studies, Prof. S. W. Wooldridge, reports that the increased bookings at the field centres and the careful husbanding and disposal of the Council's resources have led to a happier situation and a development of the Council's activities: a grant for equipment has been made to each of the four centres, while the teaching staff of three of them has been augmented by the appointment of a field assistant. In addition, substantial capital expenditure to improve comfort and accommodation has been approved at Dale Fort and Juniper Hall. The fourth annual report of the Council also describes the work at the field centres in 1954*.

At Dale Fort, marine biology again proved the greatest attraction at the centre, only geography with all its variations providing comparable numbers.

At Skokholm, work has been begun on the annual marking of puffin chicks, while many puffins were ringed to throw light on the movements, attainment of maturity, mortality and expectation of life of these birds.

Students again contributed to the long-term research projects at Flatford Mill; these included investigations into the distribution and feeding habits of flounders at the head of the estuary, and

the study of the vegetational succession taking place on mud-banks forming at the lower edge of Sherbourne Brook.

At Juniper Hall, geographical subjects of all kinds were the main interest of 53 per cent of the total number of students, while biological studies of one kind or another accounted for 39 per cent of the attendance; courses for sixth-form students from grammar schools and public schools formed the most stable element in the centre's economy.

An interesting development at Malham Tarn was the arrangement of a special course for secondary modern school teachers; this was done in conjunction with the West Riding Local Education Authority.

The report also contains details of some of the specialized work that was carried out at different centres.

NEBULÆ AND STAR CLUSTERS

AT the meeting of the Royal Astronomical Society on February 12, 1954, at Burlington House, London, the presidential address (read by Prof. H. Dingle in the unavoidable absence of the president, Dr. J. Jackson) was delivered on the occasion of the award by the Society of its Gold Medal to Dr. Walter Baade, of the Mt. Wilson and Palomar Observatories, for his observational work on galactic and extragalactic objects. The address, which has been published in full (*Mon. Not. Roy. Astro. Soc.*, 114, 3 (1954); and also *The Observatory*, 74, No. 879 (April 1954)), commenced with a brief outline of Baade's work with the reflector of 1 m. aperture at Hamburg Observatory from 1919 until 1931, when he joined the staff of the Mt. Wilson Observatory to work with Hubble on the branch which was his chief interest at Hamburg—the direct photography and photometry of nebulae and star clusters. Soon after his arrival at Mt. Wilson Observatory he undertook an investigation for determining the distance of the wispy cloud in Cygnus, a region to which he had given special attention when he was at Hamburg and in which he had found that many of the variable stars were eclipsing variables. Three classes of stars were used from Mt. Wilson observations for determining the distance—the eclipsing variables; long-period variables; and early B-type stars—and they indicated distance moduli of 12.5, 13.0 and 12.7, respectively, the latter being adopted. The question of the absorption of light in space then arose, and from the colour indices of eighty stars of type B8 to A5 a colour excess of 0.25 was found. On the assumption that this was due to pure Rayleigh scattering, Baade deduced that the Cygnus cloud was 2,630 parsecs distant; if no correction for absorption had been applied, a distance of 3,500 parsecs would follow from the adopted modulus. The few Cepheid variables found in the cloud gave very unsatisfactory results: four of long period were so faint that they could not be fitted in with the adopted modulus; two could be explained by heavy absorption; and two others might be much farther off than the cloud. In addition, five short-period cluster-type variables could not be fitted into the general result, but it was possible to explain them as belonging to the general galactic field of such objects.

The address next turned to another branch of Baade's work—that connected with novæ and supernovæ. The discovery by Ritchey in 1917 of a nova

* Council for the Promotion of Field Studies. Annual Report, 1953-54. Pp. 60+8 plates (London: Council for the Promotion of Field Studies, 1955.)

in the spiral nebula N.G.C. 6946 was followed by the discovery of many other novæ in other extragalactic systems, and these discoveries opened up a new way for the determination of the distances of these systems if an absolute magnitude could be attributed to them. The results of the first efforts at this determination proved disappointing because of the very large range of magnitudes in the luminosities of the novæ observed. This unusually large range—up to eleven magnitudes—indicated one of two things: either there was a very large dispersion in the absolute magnitudes of the novæ; or there existed two groups of novæ differing in luminosity by a factor of the order ten thousand. The second alternative was shown to be the correct one as a result of Hubble's investigations of the Andromeda nebula, and Baade concluded that, in addition to the class of fainter novæ, to which most of our galactic novæ belong, there was also a class of supernovæ the average magnitude of which was about ten magnitudes brighter and hence they were visible in nebulae so distant that the fainter novæ could not be observed there. The spectra of six supernovæ which were quite distinct from those of other stars, including ordinary novæ, obtained about the time of Baade's deductions confirmed Baade's views, which are now universally accepted. Dr. Jackson's address then went on to discuss fully the developments in this branch.

Turning now to other features in Baade's work, about a century ago Prof. G. P. Bond, in reporting on the rapid progress in photography, announced that stars to the sixth magnitude could be photographed; he then made the optimistic forecast that on some lofty mountain and in a purer atmosphere stars up to eighth magnitude might be photographed, and, by increasing the aperture threefold, all the stars up to the tenth and eleventh magnitude could be photographed. Bond lived long enough to see the aperture increase from 15 to 45 in. with a corresponding increase of about $2\frac{1}{2}$ magnitudes in the stars that could be photographed. Dr. Jackson points out that there are other methods for increasing the photographic powers of telescopes, such as changing from a long-focus refractor to a short-focus reflector (which happened when he was at Greenwich) and improvement in clockwork and engineering; but unfortunately the stage is approaching in which fogging due to the light of the night sky is of the same order of intensity as that of the images formed by the faintest stars. The hope for the future lies with the sensitive plates, and at the meeting of the International Astronomical Union in Stockholm in 1938, Baade showed photographs of obscured regions of the sky taken with a new brand of red-sensitive plate. He stated that one plate showed eight hundred thousand stars to the square degree and that, with the optical means available, the limit had not yet been reached. It was a great triumph in 1942 when plates of the Andromeda nebula, taken with the 100-in. reflector, revealed for the first time "signs of incipient resolution in the hitherto apparently amorphous central region—signs which left no doubt that a comparatively small additional gain in limiting magnitude, of perhaps 0.3 to 0.5 mag., would bring out the brightest stars in large numbers". After this it was merely a matter of time for further investigations before successful plates were secured for about the restricted range of wave-length used, 6300–6700 Å., so that the most troublesome part of the night sky was cut out.

Dr. Jackson's address dealt at length with the results obtained with these red-sensitive plates, and the following is a summary of Baade's view regarding Population i and Population ii in different regions of space (see *Astrophys. J.*, Sept. 1944). The method was applied to *M* 31 and the two companion nebulae *M* 32 and N.G.C. 205, and, following their resolution into stars, Baade suggested that there are two types of stellar populations. Population i, in which bright giants and supergiant stars are common, is found in the arms of spiral galaxies but not in their central regions, and this population includes a higher proportion of binary stars but less novæ and supernovæ than Population ii. The latter includes no star brighter than a normal giant, absolute magnitude about -2 , with comparatively low temperature, and also the high-velocity stars, stars found in globular clusters, in elliptical nebulae and in the central unsolved regions of spiral nebulae. In connexion with this subject, Baade's work on the Sagittarius cloud provides very interesting corroboration of the general view that our galaxy is a spiral nebula like the Andromeda nebula; if this resemblance is complete, the Sagittarius cloud, in the direction of which the centre of our galaxy lies, should contain stars of Population ii. Baade's investigations of this region with red-sensitive plates has shown that this is actually the case. Not only was the similarity to *M* 31 thus shown but also, allowing for a colour excess of 0.3 which involved a correction to the distance modulus of 2.6, the distance modulus was reduced to 14.7, indicating a distance of about 9 kiloparsecs. This is close to the generally accepted value for the distance to the centre of our galaxy, which is believed to be very similar in its contents to the Andromeda nebula—an intermediate spiral of type *Sb*.

At the end of Dr. Jackson's address, reference is made to the unsatisfactory position regarding determinations of very remote objects by the classical Cepheids and to the scheme which is being planned for settling the zero point. Direct trigonometric methods have supplied the distances of many stars of types *F* to *K* and, from these, reliable absolute magnitudes can be calculated. Baade hopes to observe such stars in the near future; but the work must necessarily occupy a long time as it involves not only accurate apparent magnitudes but also spectral classification or at least colour indices of very faint stars in clusters. In this scheme there lies great hope of deducing accurate absolute magnitudes not only of Cepheids but also of any other objects in the systems, and hence their distances. It is admitted, however, that the lack of transparency of space "remains a challenge but also a means of determining something about the contents of interstellar space".

JAPANESE FORESTRY RESEARCH

THREE Bulletins (Nos. 63, 64 and 65) of the Government Forest Experiment Station (Meguro, Ku, Tokyo, 1953) have been received. Nos. 64 and 65 deal with various research inquiries and studies dealing with forestry work. No. 64 is confined to research connected with studies on fog-prevention forests. Fog in Japan has a very serious effect both on agricultural and other operations in the Islands and a study of the Bulletin is of considerable interest since it presents aspects of a danger which is little known elsewhere except as a nuisance.

In Report 3 of the Station, research work into "Forest Soils of Japan" is dealt with in a monograph. The forest soil survey was undertaken of the Kamo management unit. The area surveyed is situated on the slopes of the Amaji mountain range, Izu Peninsula. The grade of weathering of this area is higher and consequently the topography is more complicated than that of the Tagata management unit, which is on the opposite face of the mountain range. This latter had been the object of a forest soil survey for beech carried out by the research station in 1951 (Report No. 1). The elevations of the Kamo research area vary from 300 m. to 1,400 m.; consequently, the climatic variations are considerable, mild at the lower elevations and severe at the higher altitudes. Fogs frequently prevail on slopes above 800-900 m. Eighty per cent of the area surveyed are artificial forests of Sugi (*Cryptomeria japonica*), a species of tree which is well known as an exotic in several parts of the world—for example, it forms the chief tree in the Station of Darjiling in the Eastern Himalaya, where it was largely planted to replace

the indigenous forest swept away while the Station was being built—and the remainder is occupied by the natural forest of *Fagus crenata* at the higher altitudes. The soils of this area belong to the brown forest soil group. There is a fine large soil map showing the distribution of these classified soils, which is more complicated than that of the Tagata area.

The Japanese Forestry Society has presumably re-commenced the publication of its *Journal*, the monthly numbers for August–November 1953 having been issued. The office of the Society is at the Government Forest Experiment Station, Meguro-Ku, Tokyo, where the *Journal* is published. A list of contents of each number is given on the back cover in English. The articles are confined to research investigations of various types which would be more suitable to the research publications of a research station than to a journal of a forestry society. But Japan is not alone in this, for several of the journals of European and other forestry societies follow the same tendency.

E. P. STEBBING

EFFECT OF IMPLANTATION SITE ON THE DEVELOPMENT OF AN IMPLANT IN THE CHICK EMBRYO

By DR. JOHN W. SAUNDERS, jun., and MARY T. GASSELING

Department of Biology, Marquette University, Milwaukee, Wisconsin

AND

DR. JOHN M. CAIRNS

Department of Anatomy, University of Oklahoma School of Medicine, Oklahoma City, Oklahoma

THE ability of leg mesoderm to control the course of regional differentiation of wing-bud ectoderm in the formation of feathers and other epidermal structures has been clearly demonstrated in the results of transplantation experiments combining leg mesoderm and wing ectoderm in the 3½–4-day chick embryo¹. Ectoderm-free mesoderm from the proximal portion of the leg bud (prospective thigh), implanted in the proximal portion of the wing bud, induces the formation of ectodermal derivatives characteristic of the proximal part of the leg (that is, thigh feathers) in the wing ectoderm which grows over the implant. Similarly, mesoderm of the distal part of the leg bud (prospective foot), implanted distally in the wing bud, has brought about the formation of epidermal structures typical of the foot (scales, large claws). Thus the regional characteristics of the induced epidermal structures correspond not only to the leg source of the mesodermal implant, but also to the precise origin of the graft along the proximo-distal axis of the leg bud.

Since, however, the grafts were placed at proximo-distal levels of the wing bud corresponding to their levels of origin in the leg bud, these results do not disclose whether the proximo-distal level of the implantation site on the wing bud, or the source of mesoderm with respect to the proximo-distal axis of the leg bud, controls the regional character of leg structures formed from wing ectoderm associated with the graft. Accordingly, experiments were undertaken to examine the effect of implantation site on the regional differentiation of leg structures

induced in wing ectoderm by an implant of leg mesoderm.

Isolates of mesoderm from the posterior proximal portion of the leg bud, the prospective material of the thigh region which forms the largest feathers of the leg, were grafted to the apex of the wing bud in embryos of stages 19 to 23 (3½–4-day embryos²) in the manner illustrated in Fig. 1. The mesodermal

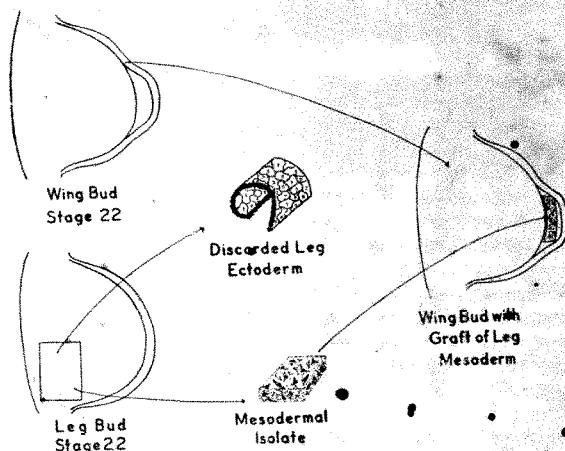


Fig. 1. Scheme of operation for combining prospective thigh mesoderm with ectoderm of the apical region of the wing. The graft becomes covered with ectoderm from the host wing bud soon after being implanted.



Fig. 2. Terminal leg parts formed by the combination of prospective thigh mesoderm and ectoderm of the distal portion of the wing. A toe, bearing typical overlapping and warty scales and a large claw, is seen

implants averaged 0.135 mm.^2 in surface area and were approximately 0.1 mm. in thickness. The apical ectoderm of the wing bud was merely loosened from the adjoining ectoderm and mesoderm, then stretched slightly, to provide a site for the graft. With this procedure, the transplanted tissues developed in a terminal position on the wing.

Twenty-three embryos operated on in this manner survived to the fourteenth day of incubation or later. Of these, twelve showed no recognizable structures of leg type on the treated wing. The remaining eleven, however, showed large claws and/or scales, typical of terminal parts of the leg, in the region of the hand. In four of these cases, there appeared distinct toes complete with scales and claws (Fig. 2). In the other seven embryos, leg structures range from imperfectly formed toes to mere patches of warty scales on the hand region of a wing which appears relatively normal in other respects.

These results fully confirm the previous conclusion¹ that leg mesoderm implanted in the wing bud may

induce epidermal derivatives of leg type in the associated wing ectoderm. Moreover, they clearly show that the regional characteristics of the induced leg structures are influenced by the proximo-distal level of the wing in which development of the graft takes place. Scales and claws have been induced by thigh mesoderm only when associated with the most apical regions of the developing wing. They have never appeared when grafts were made to the shoulder-level, or even as far distally as the wrist.

Finally, it should be noted that the environment of the wing-bud apex may modify the course of differentiation of the grafted thigh tissue itself. This seems rather evident, especially in those cases in which recognizable toes were formed. In such cases, the prospective thigh mesoderm presumably retained its quality of 'leg', but was modified in the proximo-distal character of its differentiation. In other cases specific effects of the wing environment are less clearly demonstrated. A number of grafts failed to form recognizable leg parts, and in some cases the hand was almost normal in appearance, although somewhat more massive than in the control wing. In these cases, the possibility is suggested, therefore, that modifying action of the apical wing environment brought about the formation of wing tissues from the grafted leg materials. While this interpretation may be open to some question, it seems clear that within the limb bud considerable portions of the mesoderm retain a certain developmental plasticity until late stages of development².

This investigation was supported by research grant C-1481 (C1, C2), from the National Cancer Institute, of the National Institutes of Health, Public Health Service; by a grant from the American Cancer Society, Milwaukee County Division; and by a grant from the Research Fund, University of Oklahoma School of Medicine, U.S.A. [Nov. 16

¹ Cairns, J. M., and Saunders, J. W., *J. Exp. Zool.*, [127, 221 (1954)].

² Hamburger, V., and Hamilton, H. L., *J. Morph.*, 88, 49 (1951).

³ Hamburger, V., *J. Exp. Zool.*, 77, 379 (1938); 80, 347 (1939).
Hamburger, V., and Waugh, M., *Physiol. Zool.*, 13, 367 (1940).
Wolff, E., and Kahn, J., *C.R. Acad. Sci., Paris*, 224, 1583 (1947).
Wolff, E., and Hampé, A., *C.R. Soc. Biol.*, 148, 154 (1954).
Saunders, J. W., *Anat. Rec.*, 99, 647 (1947). Rudnick, D., *Trans. Conn. Acad. Arts Sci.*, 36, 353 (1945).

A GENERAL CREEP AND RECOVERY PROPERTY OF METALS

By DR. A. J. KENNEDY

British Iron and Steel Research Association, London

IN a very large number of practical applications, metals are subjected to discontinuous stress and temperature conditions. These arise, for example, in gas turbines, where certain of the components are stressed during the running period at a fairly high temperature, and afterwards cool down and remain practically unstressed during the period when the machine is not running. In a number of such high-temperature machines, creep occurs in the metal components during the working periods, while during the off-stress periods other (recovery) processes take place. So far as transient creep is concerned, creep deformation increases the resistance to further creep, while the recovery process reduces this resistance; thus the behaviour of any particular component depends upon the whole of its previous history. In

general, the problem is extremely difficult to treat analytically, although certain useful approximations can be made, particularly when the stress cycles are fairly regular.

One general question which arises from these considerations is whether the best material for use under continuous creep conditions is also the best under the discontinuous conditions encountered in practice. Is it possible, for example, that a material which is resistant to creep may soften by recovery much more than some other material which is less resistant to creep under continuous stress conditions? The interaction of the fatigue process with such deformation and recovery mechanisms may also be important. These general questions cannot at present be answered with any certainty, but certain work on the transient

creep behaviour of a number of metals under various stress and temperature conditions has been completed and reveals a common property which is of importance in design. In order to present these results, it is necessary to make use of a mathematical treatment which has been proposed previously¹.

If a metal, under a particular set of conditions, exhibits a transient creep function of the form $\epsilon = \beta t^p$, where β and p are constants (and p a fraction), ϵ the strain and t the time of creep, then, if the stress is interrupted after some time τ for a period ρ and then reapplied, a small new transient appears. It is convenient to express the form of the new curve by introducing the concept that a fraction n of the metal has wholly recovered. It has been shown that, for an isothermal interruption test, n satisfies a relation of the form:

$$(1 - n)/n = A(\tau/\rho)^p \quad (1)$$

It was natural to assume that A would vary from metal to metal, even though p might be largely constant (it is usually near the Andrade value 0.3). In fact, for given values of τ and ρ , a number of metals, at different stresses and temperatures (but for all of which $p=0.33$), provided n -values distributed about a mean in the way shown in the inset histogram in Fig. 1. The ordinate is the number of test results obtained, the abscissa being divided into bands 0.03 wide. The mean n -value obtained provides (by the use of equation (1)) a value for A of about 9.0. This compares with values of 15 and 8 obtained in other experiments^{1,2}; and considering A may (in principle) take any value from zero to infinity, this is a good agreement.

A does, however, vary with p , as shown in Fig. 1. All the points could not be plotted for the case $p = 0.33$, and only their range is shown. The continuous curve drawn is the rectangular hyperbola $Ap = 3.0$. Substituting for A in equation (1), we find there are now no arbitrary constants.

We consider how such a result may arise. The magnitude of the initial transient has already been denoted by β ; let the transient on reloading be α . Thus (essentially) $\alpha/\beta = n$.

A dependence of transient creep on temperature of the form:

$$\epsilon = \psi[t \exp -(Q_c/RT)] \quad (2)$$

where ψ is some function, has support from Mott³ and from Dorn⁴, and is certainly widely applicable.

Q_c is the activation energy for transient creep and T the absolute temperature. R is the gas constant. Using the transient creep function βt^p , β can be rewritten as the temperature-dependent quantity $\beta_0 \exp (-pQ_c/RT)$. So far as α is concerned, we wish to establish how this quantity varies with the recovery temperature for a fixed pre-history (fixed τ , ρ , creep stress and temperature), knowing that for a wholly isothermal interruption-test α/β varies very little with temperature. Noting the similar time functions which govern creep and recovery, we suggest a dependence of the form:

$$f(\alpha) = f(\alpha_0) \exp (-pQ_R/RT) \quad (3)$$

Thus the conditions are satisfied if $f(\alpha)/\beta$ is a function of n only and if $Q_c \sim Q_R$. In particular, taking $f(\alpha) = \alpha/(\beta - \alpha)$, we derive $n/(1-n)$ as the relevant n -function in accordance with (1). Experiments can be designed to verify (2) and (3) and to determine Q_c and Q_R independently; for pure lead, we obtain $Q_c = 13,400$ and $Q_R = 19,800$ cal./mole. This is a satisfactory confirmation of their near-equality, but it does not solve the dependence of A on p . If $Q_R \sim Q_c = \Delta Q$, a small quantity, then n (for fixed p) is slightly dependent on temperature, though it may be masked by experimental scatter; n will also be slightly dependent on p , and the results will now lie along curves of the nature shown by the broken lines in Fig. 1. Taking $T_1 = 300^\circ \text{K.}$ and $T_2 = 200^\circ \text{K.}$, these curves would arise if $Q_c - Q_R = 2,400$ cal./mole. The actual values obtained above, for which $Q_R > Q_c$, would give an opposite trend. It is not possible to distinguish at present whether the general form of Fig. 1 arises in this way or not, simply because of the accuracy demanded in the determination of Q_c and Q_R , and also because ΔQ will certainly vary from metal to metal. The important general point is that Q_c and Q_R appear to be very nearly the same for all metals, suggesting that the two processes are controlled by the same basic mechanism.

Apart from their fundamental interest, these results have a practical application, as they show that the relative transient creep behaviour of materials under intermittent (on-off), as compared with continuous, stress under the same conditions is broadly a constant and does not vary significantly from one material to another, nor is it markedly dependent on the conditions of stress or temperature imposed, provided the type of creep curve exhibited (the value of p) remains the same. We are therefore led back to what might now appear to be a truism: the most successful creep-resistant materials (under continuous stress at a constant temperature) should also be the most successful under intermittent (but isothermal) conditions. It remains true that such intermittent conditions may possibly be more serious, so far as creep failure is concerned, than the continuous ones. These tests have been carried out on fairly pure metals, and although wide ranges of stress and temperature have been used, it is possible that certain more complex materials, such as creep-resistant alloys,

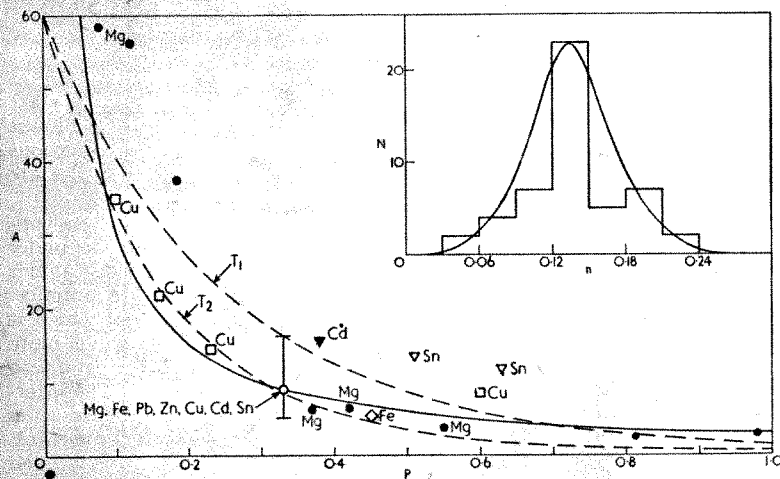


Fig. 1

under more extreme conditions, may fail to behave in this way. In particular, the influence of temperature cycles remains an important problem. Certainly under these conditions it remains possible that the best material for any particular application may not be that which is most successful under isothermal continuous-stress conditions. Much more experiment is required before this consideration can be dealt with adequately. In any event, materials which exhibit structural transformations (such as recrystallization) under the test conditions will certainly not behave simply in accordance with the

foregoing. Some progress has been made in handling these additional complications.

This work, which will be published more fully elsewhere, formed part of a research programme carried out at the Royal Institution under the Royal Society Armourers and Brasiers' Fellowship. Grateful acknowledgment is made to all these bodies for their support. [Nov. 30]

¹ Kennedy, A. J., *Proc. Roy. Soc., A*, **213**, 492 (1952).

² Kennedy, A. J., *Nature*, **171**, 927 (1953).

³ Mott, N. F., *Phil. Mag.*, **44**, 742 (1953).

⁴ Dorn, J. E., Symposium on Creep and Fracture of Metals at High Temperature, Paper No. 8 (H.M.S.O., in the press).

INHIBITION BY SIMPLE SUGARS OF ENZYMES WHICH DECOMPOSE THE BLOOD-GROUP SUBSTANCES

By DR. WINIFRED M. WATKINS* and PROF. W. T. J. MORGAN, F.R.S.

Lister Institute of Preventive Medicine, London, S.W.1

WHILE studying the action of an enzyme preparation from the protozoan flagellate *Trichomonas foetus*¹ on the blood-group receptor sites on the human erythrocyte surface, it was found that the inactivation of the *H* specific structures could be inhibited by L-fucose and D-galactosamine². This finding was of particular interest, because these sugars are components of the water-soluble *H* specific mucoid. The other two sugars contained in the carbohydrate portion of the *H*-mucoid, D-galactose and D-glucosamine, and a number of unrelated sugars, failed to inhibit appreciably the action of the enzyme. Furthermore, this observation enabled a differentiation to be made between the enzyme which inactivated the *H* receptors and that contained in the preparation which destroyed the blood-group *M* specific structures.

Many enzymes are inhibited by the products of their own activity; in the carbohydrate field this was early observed by Henri³, who found that the action of invertase on sucrose could be inhibited by the addition of large quantities of invert sugar. Armstrong and Armstrong⁴ afterwards showed that both glucose and fructose caused inhibition in this system, and also that maltase could be inhibited by glucose and methyl glucoside and lactase by galactose and methyl galactoside; a number of other sugars were without inhibitory power. More recently, Reese, Gilligan and Norkrans⁵, in studies on the action of cellulase on cellulose preparations, have found that the reaction product cellobiose inhibits the enzymic hydrolysis. As it appeared possible from our preliminary experiments that the enzyme present in *T. foetus* which destroyed *H* specificity was inhibited by sugars which were the products of its own activity, a more thorough examination of the inhibition by simple sugars of the enzymes which decompose the blood-group substances was undertaken.

The partially purified enzyme preparation used for the studies on red cells was without action on the *A* and *B* specific structures, but crude extracts of *T. foetus* contain enzymes which rapidly destroy the serological activity of the water-soluble *A* and *B* mucoids. The inhibiting action of a number of simple sugars on (a) the enzymes present in crude extracts of *T. foetus* which destroy the *A*, *B* and *H*

substances; (b) a partially purified preparation from *T. foetus* which destroys *H* activity only; and (c) a partially purified preparation from *Cl. welchii* (Type *B*) containing *A*- and *H*-destroying enzymes⁶ was therefore examined. Purified water-soluble *A*, *B* and *H* substances⁷, at a final concentration of 0.03 per cent, were used as substrates, and the percentage of the substrate inactivated by the enzyme, alone and in the presence of the sugars, was measured by means of the serological inhibition test⁸. The final concentration of the added sugar in each test was 0.66 per cent. Some of the results obtained using the *T. foetus* enzyme preparations are summarized in Table 1. The limitations of the serological inhibition test do not enable one to distinguish accurately between 50 and 100 per cent of unchanged substrate remaining after enzyme activity. In addition to the substances listed in Table 1, the following sugars, which did not give inhibition in any of the tests, were included for each enzyme: D-glucose, D- and L-arabinose, D- and L-xylose, D-ribose, L-sorbose, L-rhamnose, D-fructose, raffinose and cellobiose.

It will be seen from Table 1 that destruction of the *A* substance by the *T. foetus* enzyme was inhibited almost completely by N-acetyl galactosamine and its methyl glycoside and to a very slight extent by D-galactose, but not by any of the other sugars included in the test. Identical results were obtained using the enzyme from *Cl. welchii*. Destruction of *B* substance, by the *T. foetus* enzyme, on the other hand, was inhibited only slightly by N-acetyl galactosamine; but the same concentration of D-galactose, the α - and β -methyl galactopyranosides and certain disaccharides containing D-galactose, inhibited the action of the enzyme almost completely. The results obtained with the partially purified *H* enzyme from *T. foetus* were in agreement with those found previously in that L-fucose and D-galactosamine were strongly inhibitory; identical results were obtained with the *Cl. welchii* enzyme. The enzyme present in the crude *T. foetus* extract was inhibited only by L-fucose and not by D-galactosamine; but further examination has shown that this extract also contains an enzyme which destroys galactosamine.

These inhibition results are of value from a practical point of view because they provide a means of

* Beit Memorial Research Fellow.

Table 1. PERCENTAGE SUBSTRATE REMAINING UNCHANGED WHEN THE *T. foetus* ENZYME ACTS ON THE BLOOD-GROUP SUBSTANCES IN THE PRESENCE OF SUGARS

Sugar added	Unchanged substrate (per cent)			
	A-substance	B-substance	H-substance	
			Crude enzyme	Purified enzyme
Control (no sugar added)	3	1	1	1
L-Fucose	3	1	25	50-100
D-Fucose	3	1	—	1
L-Galactose	—	1	—	3
D-Galactose	6	50-100	1	1
N-Acetyl D-glucosamine	1	1	—	1
N-Acetyl D-galactosamine	50-100	6	—	1
D-Glucosamine	3	1	1	1
D-Galactosamine	3	6	1	50-100
α -Methyl L-fucopyranoside	3	1	—	3
β -Methyl L-fucopyranoside	—	—	—	1
α -Methyl L-fucofuranoside	3	1	—	1
β -Methyl L-fucofuranoside	3	1	—	1
α -Methyl D-galactopyranoside	3	50-100	—	1
β -Methyl D-galactopyranoside	3	50-100	—	1
β -Methyl D-galactofuranoside	—	3	—	1
Lactose	—	50-100	—	1
Melibiose	—	50-100	—	1
Methyl N-acetyl galactosaminide	50-100	—	—	—

differentially inhibiting the blood-group enzymes present in a crude mixed preparation; they are also of theoretical importance. The mechanism by which the blood-group-destroying enzymes break down the specific mucoids is unknown, as the specificity of the enzymes which brings this about has not been determined and the detailed structures of the groupings in the blood-group substances responsible for their serological activity have yet to be elucidated. Examination of the products liberated from the specific substances by enzymes from different sources⁹ has shown that extensive breakdown of the molecule frequently occurs with liberation of all the component sugars. The enzyme preparations used, however, probably contain many carbohydrate-splitting enzymes, some of which may cause further breakdown of the molecule after the first enzymic change—that is responsible for the loss of serological activity—has taken place. The enzymes inhibited by the sugars must, however, be those which produce this initial change, and therefore an examination of these inhibition reactions enables a tentative conclusion to be drawn as to the nature of the enzymes involved in the destruction of the serological activity of the three blood-group substances.

The A, B, and H substances each contain L-fucose, D-galactose, N-acetyl D-glucosamine and N-acetyl D-galactosamine; it is one of these sugars in each instance which inhibits the action of the corresponding enzyme. In view of the difficulty of measuring small changes in the concentration of the substrate, it has not been possible to carry out kinetic studies on these enzyme-inhibition reactions and thus to obtain evidence in support of the competitive nature of the inhibition. If, however, it is assumed that the enzymes are inhibited by their reaction products, it would appear that the initial change leading to loss of A serological activity involves the hydrolysis of an N-acetyl galactosamine linkage. This evidence supports earlier indications of the importance of N-acetyl galactosamine for A serological activity which were obtained from agglutination-inhibition tests using plant-seed haemagglutinins¹⁰. Since D-galactose and the galactose-containing glycosides and disaccharides alone in-

hibited specifically the destruction of B substance, the enzyme leading to loss of serological activity for this mucoid could be postulated as a galactosidase. Galactosidases from other sources have failed to inactivate the B-specific substance; but this fact does not disprove the identity of the enzyme in the *T. foetus* extract as a galactosidase because the specificity requirements, with respect to the nature and structure of the aglycon, of glycosidases from different sources may vary widely¹¹. The inhibition by L-fucose of enzymes from both *T. foetus* and *Cl. welchii* which bring about the serological inactivation of H substance supports the serological findings which have pointed to the part played by this sugar in determining H specificity. Thus anti-H agglutinins present in eel serum and in plant-seed extracts can be inhibited by L-fucose¹². It is of interest that the methyl fucopyranosides and furanosides fail to inhibit the inactivation of H substance by the enzyme, whereas the galactopyranosides inhibit the enzyme which destroys B substance. It has been shown, however, that the partially purified H enzyme from *T. foetus* is without action on the methyl fucosides, although the presence of a fucosidase in the enzyme preparation is suggested by the fact that fucose appears as one of the hydrolysis products when the enzyme is allowed to act on the H substance. The inhibition by D-galactosamine of the enzyme decomposing H substance is difficult to explain. It is believed that this hexosamine is present in the N-acetylated form in the H specific mucoid, and yet N-acetyl galactosamine is without inhibitory effect.

The results of these inhibition experiments demonstrate that the enzymic hydrolysis of each blood-group substance is inhibited by a different sugar component. Presumably, therefore, a different enzyme is involved in the decomposition of each material; and it seems probable that the sugars which bring about the inhibition observed are those which play an important part in the characteristic serological specificity of the blood-group substances. These tentative conclusions provide a basis for further studies, and it is believed that similar inhibition experiments with simple substances may yield information in other systems involving the action of enzymes of unknown specificity on complex biological materials. [Feb. 17]

¹ Watkins, W. M., *Biochem. J.*, **54**, xxxii (1953).

² Watkins, W. M., and Morgan, W. T. J., *Brit. J. Exp. Path.*, **35**, 181 (1954).

³ Henri, V., *C.R. Acad. Sci., Paris*, **135**, 916 (1902).

⁴ Armstrong, H. E., and Armstrong, E. F., *Proc. Roy. Soc., B*, **79**, 360 (1907).

⁵ Reese, E. T., Gilligan, W., and Norkrans, B., *Physiol. Plant.*, **5**, 379 (1952).

⁶ Schiff, F., *Klin. Wochschr.*, **14**, 750 (1935); *J. Infect. Dis.*, **65**, 127 (1939). Stack, M. V., and Morgan, W. T. J., *Brit. J. Exp. Path.*, **30**, 470 (1949). Crumpton, M. J., and Morgan, W. T. J., *Biochem. J.*, **54**, xxxii (1953).

⁷ Aminoff, D., Morgan, W. T. J., and Watkins, W. M., *Biochem. J.*, **46**, 426 (1950). Anison, E. F., and Morgan, W. T. J., *Biochem. J.*, **52**, 247 (1952). Gibbons, R. A., and Morgan, W. T. J., *Biochem. J.*, **57**, 285 (1954). Gibbons, R. A., Morgan, W. T. J., and Gibbons, M., *Biochem. J.* (in the press).

⁸ Morgan, W. T. J., and Watkins, W. M., *Brit. J. Exp. Path.*, **26**, 387 (1951).

⁹ Freudenberg, K., and Eichel, H., *Liebigs Ann.*, **518**, 97 (1935). Howe, C., and Kasat, E. A., *J. Amer. Chem. Soc.*, **75**, 5542 (1953). Crumpton, M. J., and Morgan, W. T. J., *Biochem. J.*, **54**, xxxii (1953).

¹⁰ Morgan, W. T. J., and Watkins, W. M., *Brit. J. Exp. Path.*, **34**, 94 (1953).

¹¹ Sumner, J. B., and Myrbäck, K., "The Enzymes", **1**, pt. 1 (Academic Press, Inc., N.Y.).

¹² Watkins, W. M., and Morgan, W. T. J., *Nature*, **169**, 825 (1952). Morgan, W. T. J., and Watkins, W. M., *Brit. J. Exp. Path.*, **34**, 94 (1953).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Indication of a Magnetic Field of the Planet Venus

If Venus had a magnetic field, it would at inferior conjunctions influence the corpuscular streams from the sun to the earth. We should expect a variation, probably a decrease, of the corpuscular intensity, which could reflect itself in the international daily magnetic character figures.

The appearance of the corpuscular streams is rather irregular, and the magnetic character figures are a rather crude measure. Further, the magnetic disturbances on the earth are caused not only by the corpuscular but also by the solar ultra-violet or X-radiation.

In order to detect the influence of Venus, it is therefore necessary to use statistical material as extensive as possible and to look for systematic variations in the averages. The magnetic character figures C are available for each day from January 1884 up to December 1953¹. During this time there were forty-four inferior conjunctions of Venus. I have tabulated the character figures for the forty-four dates of this phenomenon and the fifty days before and after each date. From this table the totals were

determined for each day from -50 to $+50$ from conjunction date for different groups of conjunctions.

The totals for C were plotted against days by the method of superposition. The points are rather scattered and in some cases the 27-day period of the solar rotation is clearly indicated. In order to avoid the influence of a recurrent maximum or minimum of solar activity in the interval around zero day (conjunction), each value of the C -totals was corrected for the average deviation of the values at the twenty-seventh day before and after. The application of this correction was confined to twenty-three days before and seventeen days after conjunction, to avoid the influence on distant parts of the curves of the peculiarities which are shown in the curves between ten days before and four days after conjunction.

Fig. 1, curve (a), all conjunctions (44 in number). The lower values at zero day and a few days before are not much more significant than those occurring at other times.

Curves (b) and (c), sunspot number R greater than 50 (19) and R less than 50 (25), respectively. The effect of corpuscular streams on magnetic activity will be more pronounced in years of small solar activity, since during greater activity the relative effect of ultra-violet radiation is increased. Therefore the conjunctions of Venus were divided into groups of years in which the sunspot numbers R are greater than and less than 50 respectively. A dip from some

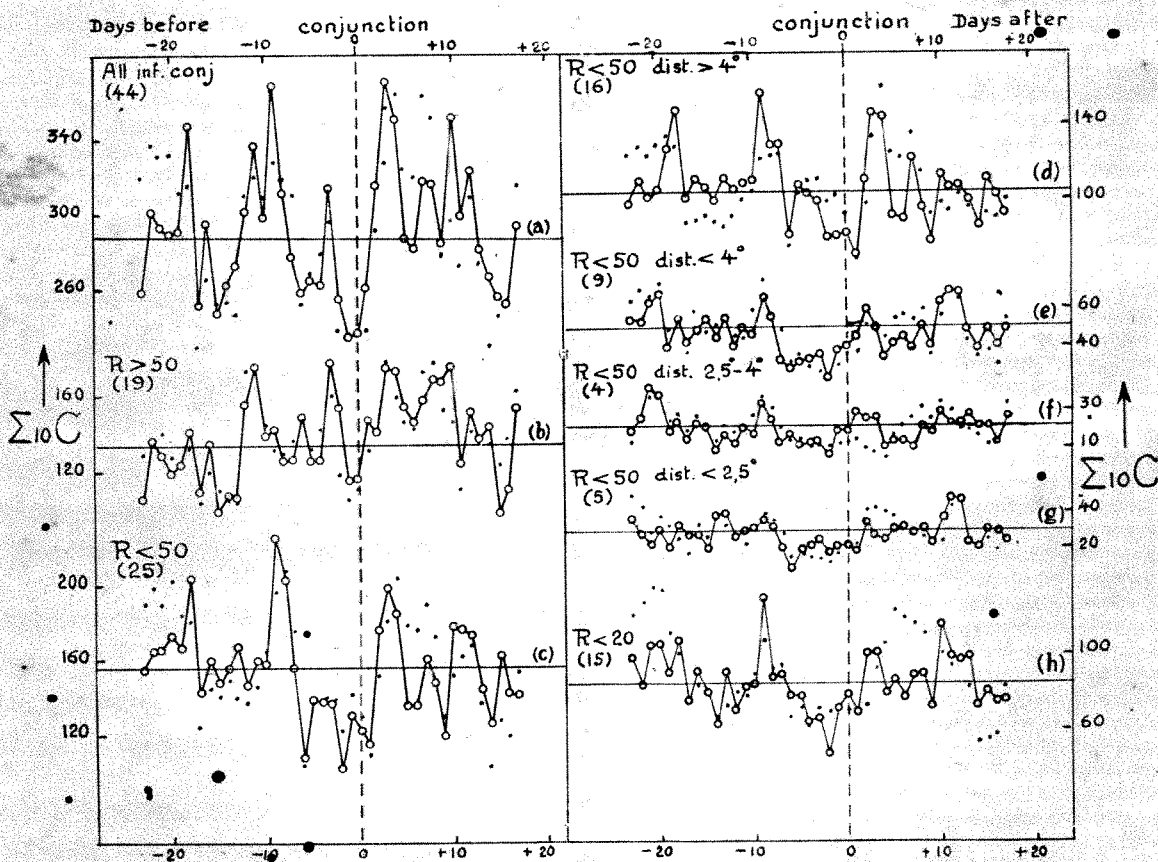


Fig. 1. Totals for C (international daily magnetic character figure), multiplied by 10, for the days from 23 before to 17 after inferior conjunctions of Venus, for the groups of conjunctions with different values of R (yearly relative sunspot number for the year of conjunction) and different angular distances between Venus and the sun at the moment of conjunction. ●, Direct plots; ○, corrected for the 27-day period of disturbances

days before until a few days after conjunction is fairly clearly indicated in the group with R less than 50.

Curves (d) and (e). Here we select the cases where R is less than 50 and the angular distances Sun-Venus are greater than and less than 4° respectively. Both groups show the dip already indicated by curve (c).

Curves (f) and (g). The subdivision of (e) into groups of angular distances at conjunction between $0^\circ-2\frac{1}{2}^\circ$ and $2\frac{1}{2}^\circ-4^\circ$ reveals that both groups show about the same decrease. Strong support of the reality of the effect is that the dip around zero day is common to all groups for R less than 50. A common maximum at nine days before, and perhaps one at two to three days after, conjunction is in some cases indicated. All other irregularities are different in type.

Curve (h). R less than 20 (15). This curve shows the closest analogy with curve (e).

The conclusion is that there is a marked decrease in the magnetic activity from seven days before to one day after conjunction. Comparing the curves for the selected groups and judging according to what we should expect, the presence of a real phenomenon is strongly suggested. Other details are still too uncertain to draw conclusions.

An estimation of the strength of the magnetic field of Venus starting from the observational material given above can only be a rough one, because of the complexity of the influence of a magnetic field on a stream of corpuscles, the properties of which are so little known. The asymmetry of the decrease around zero day suggests a deflexion of the corpuscular stream by Venus. If the magnetic axis of Venus should be orientated nearly perpendicularly to the plane of the orbit, then an electrically charged particle moving in, or nearly in, this plane would experience a force that would curve the path in the plane. In one of the two orientations of the magnetic field, the particle might be deflected in the direction opposite to the movement of Venus and the earth around the sun; in this case, before conjunction, the earth passes through a region of dispersion of the cloud; then, after conjunction, there will be a more concentrated stream to the earth. In any event, it would not be unexpected to find the minimum displaced from that for zero day. If the cloud was not deflected by Venus, but only the earth is shielded by Venus, the effect would be imperceptibly small; a minimum would occur on earth at a time after conjunction corresponding to the time needed by the corpuscular shadow that lags behind Venus to pass over the distance from conjunction to the earth.

At the moment of the beginning of the depression in the corpuscular intensity, seven days before conjunction, the earth will be in a region of the stream where the divergence has just become perceptible. We estimate rather arbitrarily that at that time the deflexion of the corpuscular rays reaching the earth may be of the order of 5° (α). In these circumstances it can easily be seen that particles with a velocity² of 500 km./sec. will have passed Venus at a distance $r_0 = 14 \times 10^6$ km. Assuming a dipole field around Venus, the expression for the magnetic field strength is

$$H(r_0) = \frac{mc}{2e} \cdot \frac{V_{\text{corp.}}}{r_0} \cdot \sin \alpha.$$

Substituting the values for protons with a velocity of 500 km./sec., we find, at $r_0 = 14 \times 10^6$ km., $H = 1.5 \times 10^{-10}$ oersted. For the earth at the same distance, assum-

ing again a dipole field, the field-strength is 0.3×10^{-10} oersted. As the problem is put here, the north-south orientation of the magnetic field of Venus is the same as that of the earth.

These considerations are, of course, much too simple to represent the real situation. In reality, the problem has essentially a three-dimensional character; for example, the magnetic fields to the north and south of the equatorial plane of Venus will play their part. Furthermore, the stream will consist of particles of different velocities and masses; and the stream will be electrically neutral, in which case the deflexion will be caused by the polarization of the moving streams in the magnetic field of Venus, and unless the densities are extremely small, a much stronger field will be necessary. This could be of importance for the explanation of the oblateness of the zodiacal gas cloud³.

All these considerations direct the attention to the need for more theoretical work on this subject. As is clear from the complicated calculations on cosmic rays and the cause of magnetic storms and related problems, the task will not be an easy one. From the observational point of view, a detailed investigation of the magnetic variations during the weeks around conjunctions of Venus would be quite interesting; there seems to be here a unique opportunity of observing the influence of a planetary magnetic field on the corpuscular streams from the sun, not on the planet itself, which was hitherto the only possibility, but by studying the stream after its passage through such a field. A third attack on the problem must necessarily be the testing of the significance of the phenomenon by thorough statistical methods. Provisionally it seems that the observational evidence, if not conclusive, points in any event with fair probability towards the reality of the suspected relation.

I hope to investigate also whether there is a similar influence of Mercury; the moon will presumably be too close to show this phenomenon. However, in both cases the existence of a magnetic field is doubtful, since these bodies appear to have no liquid core.

J. HOUTGAST

Sterrenwacht "Sonnenborgh",
Utrecht.
Jan. 25.

¹ Bartels, J., *Abh. Akad. Wissenschaften* (Göttingen, 1951). Chapman, S., and Bartels, J., "Geomagnetism", 2 (1940), supplemented by the yearly surveys of character figures.

² Kiepenheuer, K. O., "The Sun", chapter 6 (1953).

³ Öpik, E. J., *Z. Astrophys.*, 35, 43 (1954).

Photographic Preparation of Masks of Large Molecules for the Lipson Diffractometer

THE optical diffractometer¹ developed by Lipson and others is being used in this laboratory for work on the structure of deoxyribose nucleic acid. This instrument has already proved its value, in work on structures of smaller molecules, as a rapid means of obtaining diffraction patterns due to trial structures, and it should clearly lend itself to application in the field of macromolecular structure in cases where enough is already known of the chemistry to enable trial structures to be produced. In the usual form, a projection of the trial structure is represented by

holes punched in an opaque mask, and the Fourier transform of this mask is obtained optically. A difficulty arises, however, in the application to large molecules, in that there is a minimum size of hole (about 0.5 mm. diameter) that can be punched in the mask. As a consequence, a large molecule can only be represented by covering a large area of the mask with holes. This gives a diffraction pattern on a very small scale, and it is found difficult to obtain the pattern without some distortion due to slight imperfections in the lens system.

It is therefore desirable that the mask should be produced on a smaller scale, and this means that the size of hole must be made still less. This can be done by photographic reduction; but the irregular variations in optical thickness of the glass plate and the gelatine coating will give rise to phase differences between the waves transmitted by the holes, which will alter the diffraction pattern. These differences can be partly avoided by sandwiching the plate between two optical flats and filling the spaces between the plate and the flats with cedar-wood oil, as was done by Bragg and Stokes² and H. Wyckoff (private communication); but this may not completely eliminate phase differences. A better method is to use a photographic technique in which the transparent parts of the gelatine in the photographic reduction of the mask can be dissolved away to leave clear holes. The present communication describes two methods of obtaining a mask using standard industrial photographic etching processes.

The required projection, for example, a few repeats of the unit cell content, is arranged as a number of positive transparencies on an evenly illuminated sheet of flashed opal glass. A photographic reduction of this series of units is then made directly on to Kodalith 'stripping film', which is processed by the method of 'etch bleach' reversal described in Kodak data sheet PH.5. It is found best to use a non-hardening fixing solution. The processed film is soaked in water at room temperature until the emulsion on its supporting

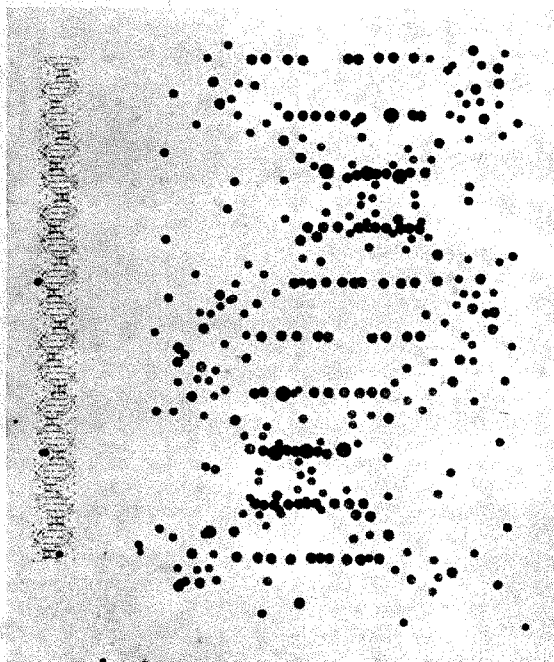


Fig. 1

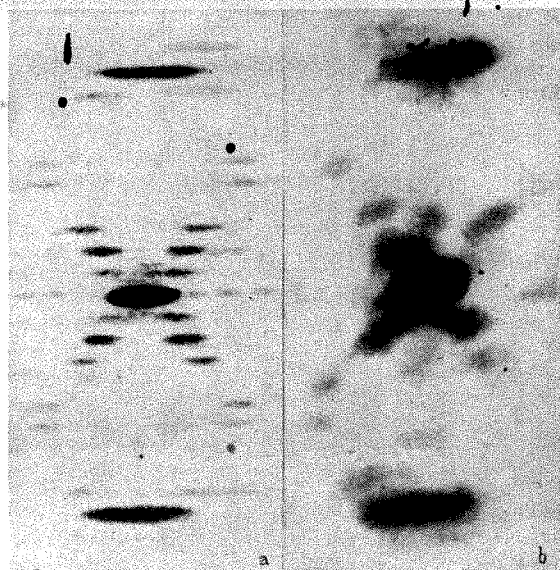


Fig. 2. Diffraction patterns from (a) photo-reduced mask, (b) punched mask

membrane strips off readily. This membrane is laid emulsion downwards on the surface of an optical flat, excess water is gently squeezed off, and the membrane is allowed to dry. When thoroughly dry, the supporting membrane is dissolved away with acetone and the mask is ready for use in the diffractometer. The mask may be examined under the microscope for possible defects, such as error of hole size, incomplete removal of the stripping membrane, or uneven shrinkage.

Using the method described, it is possible, with a reasonably good camera lens, to obtain a photographic reduction with a minimum size of hole of about 100μ over a circle of 5 cm. radius, and no difficulty is experienced in the processing. The method can be used for obtaining very much smaller holes ($\sim 30\mu$) in the emulsion, but the relative size of the holes varies greatly with exposure and processing, and a minimum hole of 100μ seems a reasonable compromise. No difficulty has been experienced due to shrinkage or distortion of the stripped emulsion membrane. The projection of one turn of the helical model of deoxy-ribose nucleic acid, together with the reduced mask is shown in Fig. 1 (actual size). Fig. 2a shows the diffraction pattern given by this mask, and Fig. 2b the pattern given by the original punched mask for comparison. The poor quality of the second pattern, as compared with those usually obtained from punched masks of smaller structures, is, of course, due to the large linear dimensions of the mask and the consequent small dimensions of the diffraction pattern.

An alternative method of preparation of the reduced mask, in which the minimum size of hole may be very much smaller than 100μ , is by coating a silvered optical flat with a very thin layer of light-sensitive colloid, for example, bichromate gelatine. A negative is contact-printed on the colloid, and in those regions where there has been no exposure the colloid is dissolved away by the appropriate developer; the underlying silver is afterwards removed with an etching solution. To obtain the maximum resolution with this method the process requires very careful control.

We wish to thank Prof. J. T. Randall for encouragement and Dr. M. H. F. Wilkins for helpful discussion. Dr. G. W. W. Stevens, of Kodak, Ltd., and Mr

F. Smith, of the London School of Printing, for advice on photographic methods. One of us (V. E. S.) wishes to acknowledge a grant from the British Empire Cancer Campaign.

C. W. HOOPER

Medical Research Council
Biophysics Research Unit,
King's College, London, W.C.2.

W. E. SEEDS
A. R. STOKES

Wheatsstone Physics Laboratory,
King's College, London, W.C.2.
March 3.

¹ Hughes, W., and Taylor, C. A., *J. Sci. Instr.*, **30**, 105 (1953).
² Bragg, W. L., and Stokes, A. R., *Nature*, **156**, 332 (1945).

Doppler Spectrum of Sea Echo at 13.56 Mc/s.

THE Doppler frequency shift of radio waves reflected from the sea surface at 13.56 Mc/s. has been recorded and a portion of a typical record is shown in Fig. 1. Such records show the following unexpected features: (a) the frequency of the principal component (as initially obtained by measurement of the length of individual cycles on the record) is surprisingly constant at about 0.38 c./s., irrespective of wind conditions and state of the sea; (b) the records show that the range of frequencies present is small. Spectrum analysis of the records made with an Admiralty wave analyser¹ confirmed these findings. Fig. 2 is a reproduction of a sample spectrum analysis which shows a large but narrow peak at a frequency of 0.38 c./s. accompanied by a smaller peak at a frequency of about 0.54 c./s.

A tentative explanation of these features can be offered if it is assumed that the sea waves act as diffraction gratings. It is known² that, under a given wind, sea waves of all lengths up to a maximum dependent on the wind velocity are generated. Of this multiplicity of waves, some travelling radially to the antenna will have a wave-length L and will reflect back a large signal when $L = \lambda/2$, λ being the radio wave-length. Since the velocity v of a sea wave of length L is given by $v = \sqrt{\frac{g}{2\pi}} L$, g being the acceleration due to gravity, then the Doppler shift Δf of this enhanced signal will be

$$\Delta f = \frac{2v}{\lambda} = \frac{2}{\lambda} \sqrt{\frac{g}{2\pi}} \cdot \frac{\lambda}{2} = \sqrt{\frac{g}{\pi}} \cdot \frac{1}{\lambda}$$

In the present case, $\lambda = 22.1$ m., $g = 9.81$ m./sec.², gives $\Delta f = 0.376$ c./s., agreeing closely with the value for $\Delta f = 0.38$ c./s. found from Fig. 2.

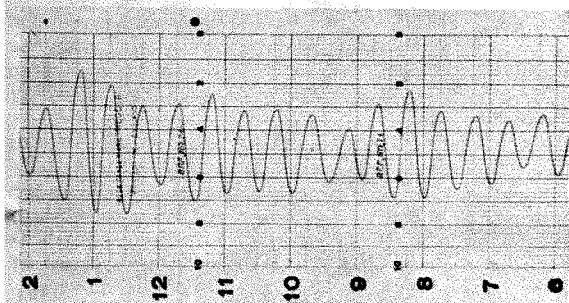


Fig. 1

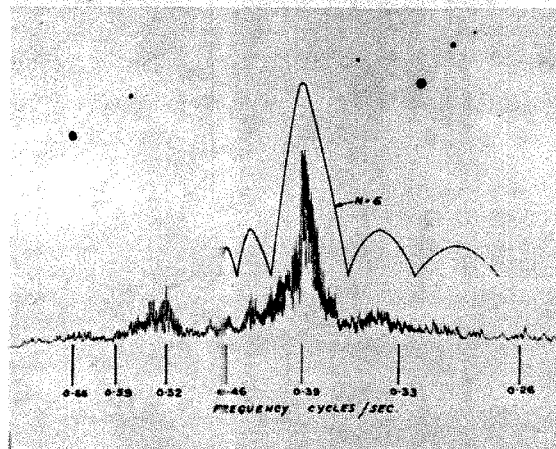


Fig. 2

It might also be expected that components of non-sinusoidal waves of wave-length $L = n\lambda/2$, n being an integer, travelling radially towards the antenna, would cause reinforcement and thus large reflected signals. These would then have Doppler shifts

$$\Delta f = \sqrt{\frac{g}{\pi}} \frac{n}{\lambda}$$

The subsidiary peak in Fig. 2 at a frequency of 0.54 c./s. $\approx 0.38 \sqrt{2}$ thus suggests that this is due to waves having a length $L = \lambda$.

Both the peaks in Fig. 2 depart considerably from line spectra. At first sight this could be explained by considering that the relatively short waves of length $L \approx \lambda/2$ are superimposed on the crests of much longer waves and thus have velocities dependent on the lengths and heights of the larger waves. However, this would lead to a continuous spectrum, whereas in the neighbourhood of the larger peak in Fig. 2 there are small subsidiary maxima which on this argument would be unlikely to occur. An alternative explanation of the shape of the spectra is that the sea waves exist in short trains. The first-order ($n = 1$) diffraction patterns of short sea-wave gratings of variable spacing L have been calculated,

$$\text{and by the use of the relation } \Delta f = \frac{2}{\pi} \sqrt{\frac{g}{2\pi}} \cdot L,$$

may be drawn as Doppler shift spectra. Superimposed on Fig. 2 is such a spectrum obtained for a grating containing six wave crests. The agreement is considered to be good. This may be of interest to oceanographers, since the explanation does not completely conform with accepted ideas of the behaviour of sea waves.

The explanation above would suggest that by the use of radio waves of lower frequency longer sea waves would be observed, and that the use of an equipment of variable frequency would result in a sea-wave spectrometer. At very high frequencies under extremely calm conditions, however, when sea waves of length comparable with the radio wave-length are dominant, similar results to those found here at lower frequencies should be obtained.

It is interesting to note that, because capillary waves have a velocity which decreases with wave-length, then the Doppler shift for radio wave-lengths less than 4 cm. under very calm conditions should increase more rapidly with decreasing wave-length than at longer radio wave-lengths. Under normal

conditions, however, when waves of much greater length are dominant, then in the expression for Doppler shift $\Delta f = \sqrt{\frac{g}{\pi}} \cdot \frac{n}{\lambda}$, n will be large and a continuous spectrum may result if the mechanism suggested above is responsible.

I am indebted to Mr. N. F. Barber for valuable discussions on sea waves and to Mr. W. H. Ward under whose direction this work was undertaken.

D. D. CROMBIE

Dominion Physical Laboratory,
Lower Hutt,
New Zealand.

¹ Barber, N. F., *Nature*, 158, 329 (1946).

² Russel, R. C. H., and MacMillan, D. H., "Waves and Tides", 58 (Hutchinson, London, 1952).

Effects of Temperature and High-speed Sliding on the Friction of 'Teflon' on 'Teflon'

In a recent study in this laboratory of the frictional properties of 'Teflon' (polytetrafluoroethylene) two experimental results stand out: (1) the coefficient of friction at low sliding speeds is very low (0.05–0.08), as reported in the literature, only if the surfaces have not previously been subjected to high-speed sliding; (2) with rising temperature, there is a marked increase in the friction of 'Teflon' on 'Teflon' in the vicinity of 20° C., where a phase transition in 'Teflon' is known to occur.

The observation was made by causing a 'Teflon' rider to bear against a rotating 'Teflon' cylinder, the friction being measured by means of strain gauges attached to the flexible rider holder¹.

The first of the experimental results serves to illustrate the important effects which surface preparation and conditioning may have on friction. It has been found, for example, that clean, newly prepared surfaces in sliding contact at low speed (1.1 cm./sec.) exhibit low friction for at least 4,100 traversals over the same track. On the other hand, if the same surfaces are subjected to sliding at high speed (189 cm./sec.), the friction increases ($\mu_k = 0.36$) and the condition of the track becomes irreversibly changed. Subsequent sliding at low speed is then accompanied by a two- to three-fold increase in the friction coefficient over the original low-speed value.

These observations do not contradict previous work in other laboratories on the friction of 'Teflon' on 'Teflon' but rather supplement it^{2,3}. Previous workers have presumably used new surfaces and have measured either static coefficients or kinetic coefficients at sliding speeds of the order of 0.01 cm./sec. Bowers, Clinton and Zisman³ studied the friction of steel rubbing on 'Teflon' and found that both μ_s and μ_k increased slightly after thirty passes (the steel rider being cleaned after each pass) and after a hundred passes μ_s had increased to 0.13 and μ_k to 0.08. To the best of our knowledge, there is no previous mention in the literature of the effect of continuous sliding on the friction of 'Teflon' on 'Teflon'.

The second result of particular importance is the relationship between friction and temperature for 'Teflon' on 'Teflon'. By varying the temperature of the cylinder within the range 12°–30° C., it has been found that a sharp increase in friction (about two-fold) takes place as the temperature is raised through 17° C. In view of the fact that the bulk temperature of the rider is above that of the cylinder,

and that localized heating effects may also be present, there can be little doubt but that the rise in friction is related to the phase transition in 'Teflon' which takes place at 20° C. This change in friction is reversible, as apart from the irreversible change produced by high-speed sliding.

A more complete discussion of these and other frictional properties of 'Teflon' will be published at a later date. It is important, for the present, to emphasize the close relationship between the frictional and structural changes which take place in this polymer.

One of us (D. G. F.) wishes to acknowledge helpful discussions with Dr. J. D. Hoffman, who first directed our attention to the phase transition at room temperature in 'Teflon'.

D. G. FLOM
N. T. PORILE*

General Electric Research Laboratory,
Schenectady, New York.
Dec. 29.

* Present address: Dept. of Chemistry, University of Chicago, Chicago, Illinois.

¹ Flom, D. G., *Rev. Sci. Instr.*, [26, 1 (1955)].

² Shooter, K. V., and Thomas, P. H., *Research*, 2, 533 (1949). Shooter, K. V., and Tabor, D., *Proc. Phys. Soc.*, B, 65, 661 (1952). King, B. F., and Tabor, D., *Proc. Phys. Soc.*, B, 65, 728 (1953).

³ Bowers, R. C., Clinton, W. C., and Zisman, W. A., *NRL Report* 4187 (1953).

⁴ Rigby, H. A., and Bunn, C. W., *Nature*, 164, 583 (1949). Quinn, F. A., Roberts, D. E., and Work, R. N., *J. App. Phys.*, 22, 1085 (1951). Furukawa, G. T., McCoskey, R. E., and King, G. J., *J. Research Nat. Bur. Stand.*, 49, 273 (1952). Weir, C. E., *J. Research Nat. Bur. Stand.*, 50, 95 (1953). Bunn, C. W., and Howells, E. R., *Nature*, 174, 549 (1954).

Rotations, Orientations and Collisions of Suspended Particles in Velocity Gradients

PARTICLES suspended in a liquid subjected to a velocity gradient undergo rotational and translational movements. For fluid velocities u, v, w , along the x, y - and z -axes given by $u = Gy$, and $v, w = 0$, Jeffery¹ has shown that a prolate spheroid of axial ratio r , in the absence of Brownian motion and interaction with other particles, rotates with a period

$$T = 2\pi(r + 1/r)/G \quad (1)$$

in a fixed spherical elliptical orbit described² by

$$\tan \lambda = Cr \sin 2\pi t/T \quad (2)$$

where λ is the angle between the z -axis and the x - z projection of the main particle axis and C is the orbit constant. The particle, when viewed as its projection on the shear planes, should therefore appear to oscillate between $\pm \lambda_{\max} = \tan^{-1} Cr$.

Measurements² on single rods have shown excellent agreement with equation 2. Values of T , however, were less than given by equation 1; this effect has been attributed to the cylindrical, rather than ellipsoidal, shape. It could not be established definitely that C remained constant with time.

The interaction of equal-sized glass spheres, brought into collision by translational motion as proposed by v. Smoluchowski³, was also studied in some detail⁴. Absolute collision frequencies, persistence times and rotational velocities of the transitory doublets were found to be in excellent agreement with calculated values; but conclusive proof of true physical contact between the spheres was lacking.

We have extended these observations using various particles suspended in corn syrup of viscosity 80 p. at values of G up to 2.5 sec.⁻¹.

It has now been established that, in the absence of interaction, a single straight rigid rod rotates in an orbit which remains constant over hundreds of successive particle rotations. This differs from earlier cursory observations by other workers³, who report a drift to $\lambda_{\max} = 0$ or $\pi/2$.

The variation in rotational velocity of a rod at various positions in its orbit yields preferred orientations in various reference planes. Instantaneous distributions of λ , determined after shearing initially isotropic suspensions, yielded a steady-state distribution with a preferred orientation along $\lambda = \pi/2$, that is, in the direction of flow, after about 3,000 particle rotations. The orientation distribution functions can also be calculated from Jeffery's equations for single particles and the distribution function of C . Jeffery¹ assumed that at statistical equilibrium the viscosity tends to its minimum value, that is, $\lambda_{\max}$, $C = 0$ for all particles, while Eizenschitz² assumed that each particle retains its original orbit. We have found the actual distributions to lie between those calculated from the two sets of assumptions. To establish a steady state, each particle must undergo a change both in rotational phase and in C ; these changes occur as a result of collision between orbits. The distribution of particle orbits, which determines among other things the viscosity of a suspension, is therefore governed by the mechanics of particle interaction.

In mixed suspensions of glass spheres of diameters a_1 and a_2 , interactions vary with a_1/a_2 . When $\frac{1}{2} < a_1/a_2 < 1$, collisions are well defined and similar to those of equal-sized spheres⁴. From the assumptions made previously⁴, the number of collisions per unit time suffered by a type-1 with type-2 spheres is readily shown to be

$$f_{1,2} = \frac{1}{6} (a_1 + a_2)^2 n_2 G$$

where n_2 is the number concentration of type-2 spheres.

Direct measurements of more than 860 collisions in suspensions with $a_1 = 180\mu$ and $a_2 = 117\mu$ yielded $f_{\text{obs}}/f_{\text{calc}} = 1.09$; this is within the estimated limits of error.

As a_1/a_2 is reduced below 0.5, the phenomena of interaction appear to change gradually. Instead of making apparent contact, a small sphere on approaching a large one executes either (i) planetary motion around the larger sphere for a definite number of revolutions, or (ii) an oscillating motion roughly parallel to the x -axis, and then separates. In both types of interaction, the spheres can be seen to be separated at all times. It is concluded from these observations that true physical contact does not occur during the life of doublets of equal-sized spheres.

Up to the highest shear-rates attainable, single air bubbles having diameters up to 200μ show no measurable distortion and rotate with the same angular velocities as rigid spheres, that is, $\omega = G/2$. This accords with Garner's observations that at low Reynolds numbers sedimenting fluid spheres behave as though solid⁷. Upon interaction, two bubbles of equal size form a doublet; but, instead of the mirror-image separation observed with neutral rigid spheres⁴, the doublet continues for as many as fifty rotations, and then the pair suddenly coalesces into a single sphere. This suggests that, while the particles may not actually collide, they approach each other initially close enough to allow attractive forces associated with

the surface to come into play and afterwards hold the spheres together.

These experiments were carried out as part of a study of the aggregation of paper-making fibres; but the results are also of interest in connexion with flow behaviour and particle aggregation in suspensions, colloidal sols and solutions of macromolecules. Experimental details and discussion will be published elsewhere.

R. ST. J. MANLEY
A. P. ARLOV
S. G. MASON

Pulp and Paper Research Institute of Canada,
Montreal, Quebec.

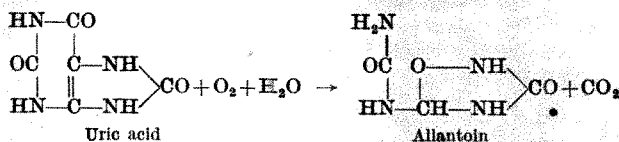
Aug. 18.

- ¹ Jeffery, G. B., *Proc. Roy. Soc., A*, **102**, 161 (1922).
- ² Trevelyan, B. J., and Mason, S. G., *J. Colloid Sci.*, **6**, 354 (1951).
- ³ v. Smoluchowski, M., *Z. phys. Chem.*, **92**, 129 (1917).
- ⁴ Manley, R. St. J., and Mason, S. G., *J. Coll. Sci.*, **7**, 354 (1952).
- ⁵ Taylor, G. I., *Proc. Roy. Soc., A*, **103**, 58 (1923). Eirich, F., Bunzl, M., and Margaretha, H., *Kolloid Z.*, **75**, 20 (1936). Binder, A., *J. App. Phys.*, **19**, 711 (1939).
- ⁶ Eizenschitz, R., *Z. phys. Chem.*, **A**, **153**, 85 (1932).
- ⁷ Garner, F. H., *Trans. Inst. Chem. Eng.*, **28**, 88 (1950).

The Origin of Man

ALTHOUGH the Darwin-Mendel-De Vries theory of evolution provides a general frame for understanding the emergence of man, it leaves open crucial questions of detail. Why have man, and, to a lesser extent, the higher apes so strikingly exceeded other animals in intellectual development? Was it by the chance accumulation of a vast number of favourable mutations, each relatively insignificant? In other words, was their development like the cascading of the ball on Galton's board from peg to peg until it happens to fall into the outermost compartment at the bottom? Or can one recognize distinct turning-points of the development? A well-known fact of physiology, the possible evolutionary significance of which does not seem to have received attention, points strongly towards the second alternative.

Mammals are distinguished from other vertebrates and from insects by their ability to produce the enzyme uricase, which oxidizes uric acid to allantoin by breaking up its purine ring according to the scheme:



The only exceptions to this are man and the higher apes, which have lost the capacity for synthesizing uricase and which, therefore, end the metabolism and catabolism of nucleoproteins with uric acid, instead of carrying it on to allantoin. Until recently, the Dalmatian dog (coach-hound) was also thought to be an exception. However, it has been found¹ that this animal does possess sufficient amounts of uricase; it excretes uric acid merely because, owing to the effect of a simple recessive gene², no tubular re-absorption of uric acid from the glomerular filtrate takes place in its kidneys³.

Uric acid has two remarkable properties. It is very sparingly soluble in water; meat-eating animals that lack uricase, therefore, have to maintain a steady

high concentration of uric acid in their blood in order to eliminate the amount they produce. Moreover, uric acid, in common with other purines such as caffeine or theobromine, is a cerebral stimulant. Consequently, animals that eat nucleoproteins but lack uricase are under constant influence of a powerful stimulant.

This circumstance may have played a decisive part in the intellectual development of the higher primates. The selective value of a small beneficial mutation of the associative mechanism of the brain must be very small, unless the animal uses its brain even when this is not urgently necessary; that is, unless it thinks about past experiences and future possibilities in times when there is no acute need for thinking. Such a tendency to philosophical reflexion must be very unusual in animals; even modern man has, in general, no irresistible addiction to mental work. A beneficial mutation of the associative mechanism of the brain, therefore, has only a poor chance of establishing itself in the species unless its selective value is strongly enhanced by the action of a cerebral stimulant such as is uric acid. The mutations that have led to the loss of uricase, then, may have been a crucial step on the way to the development of man.

In all probability the loss of uricase was not a sudden event due to a single mutation. Some monkeys seem to show a slightly impaired capacity for uricase production: this suggests a gradual assembly of the gene-constellation that has ultimately led to the almost complete absence of uricase. In the lower mammals, this assembly did not progress beyond a primitive stage, because the higher brain functions were relatively undeveloped, and the effects of their stimulation by uric acid could not counter-balance the physiological disadvantages of this compound. From a certain stage of the brain development onwards, however, the increment of viability due to uric acid must have changed its sign from negative to positive, and then the assembly of the uricase-loss gene constellation could progress hand in hand with the accelerated development of the brain due to the increasing level of uric acid concentration.

Can the viability-increment due to a stimulant be large enough to cause such momentous developments? Although quantitative indications are lacking, there is a strongly positive body of general experience. The triumph of will-power and 'drive' (that is, of certain internally secreted or otherwise produced stimulants) over innate talent was a popular theme of all literatures long before *Æsop's* tale of the hare and the tortoise. Millions of the present generation owe their careers, and some even their lives, to caffeine or theobromine, taken during preparation for an examination, a negotiation, or during a strenuous car-drive. Uric acid, of course, is not so effective as coffee or tea; but its effect as a catalyser of mental development has extended over a million years, starting probably long before the Oligocene branching of the great orthograde primates. A widespread popular opinion associates the vigour and initiative of the populations of the wealthy industrial areas with their high meat consumption. It is well known that a small fraction of this consumption would be sufficient for tissue regeneration; if the popular opinion has any solid foundation, therefore, a more likely reason for the effect of nucleoproteins is the high level of uric acid concentration in the blood. In fact, it is quite likely

that the 'pressure-of-life' diseases prevalent in the highly industrialized areas are, to a considerable extent, 'pressure-of-uric acid' diseases. Although not so effective as caffeine or theobromine, this stimulant can be a more powerful inhibitor of rest and recovery from work by its action extending over day and night.

E. OROWAN

Department of Mechanical Engineering,
Massachusetts Institute of Technology,
Cambridge, Mass.

Dec. 25.

¹ Wells, H. G., *J. Biol. Chem.*, **35**, 221 (1918). Klemperer, F. W., Trimble, H. C., and Hastings, A. B., *J. Biol. Chem.*, **125**, 445 (1938).

² Trimble, H. C., and Keeler, C. E., *J. Hered.*, **29**, 280 (1938).

³ Friedman, M., and Byers, S. O., *J. Biol. Chem.*, **175**, 727 (1948).

Variation in the Amounts of Deoxyribonucleic Acid in the Cell Nuclei and its Correlation with Mitotic Activity: Compensatory Hypertrophy of the Kidney

THE deoxyribonucleic acid content of the interphasic nuclei is, for a given species, approximately the same in the different tissues and double that of the spermatic nuclei of the same species. However, it is known that certain organs contain different classes of nuclei with an amount of deoxyribonucleic acid that is a simple multiple of the basic value. This constancy of deoxyribonucleic acid content is considered by some to be absolute¹; others claim on the contrary that the 'theoretical diploid value' is only an equilibrium value, from which the mean content varies more or less widely, as a function of the physiological² or mitotic activity³ of the cells. The influence of mitotic activity upon the deoxyribonucleic acid content of the nuclei of the tubuli in a kidney showing compensatory hypertrophy after extirpation of the kidney on the other side has been studied by us.

The left kidney of five white rats was extirpated; the animals were killed, together with five controls, seven days after intervention. Nephrectomized animals and controls received 9 hr. before death an injection of colchicine (0.2 mgm./100 gm. total weight) in order to block the mitoses in metaphase. The right kidneys of the different animals were utilized in our work. They were fixed in a mixture of alcohol 96° (75 parts), formol 40° (20 parts) and acetic acid (5 parts); a testicle of a control rat was also fixed. All the dehydration operations and embedding were performed simultaneously. The sections (10 microns) were placed on the same slide and treated by the Feulgen reaction. The intensity of the mitotic activity was determined approximately by counting the stathmocineses per 1,000 nuclei in the tubuli contorti I. For the nephrectomized rats about 5 per thousand mitoses were found. In the controls the mitotic activity was very low indeed: examination of the whole section showed only one or two mitoses. The increased mitotic activity is correlated with compensatory hypertrophy (about 30 per cent in weight).

The relative deoxyribonucleic acid content of the individual nuclei was measured *in situ* on the Feulgen-stained preparations with Lison's histophotometer⁴. In every kidney a hundred interphasic nuclei were measured; in order to determine the theoretical diploid value, a hundred nuclei of spermatocytes I were also measured.

The mean values of the five controls are statistically very constant and obviously less than the theoretical diploid value (mean deoxyribonucleic acid content of spermatocyte I/2 = 980.1 ± 7.98). The mean values of the nephrectomized rats show a clear tendency to increase, without reaching the theoretical diploid value. In order to demonstrate objectively this impression we pooled the measurements in each group.

Pooled results	<i>n</i>	$\bar{x} \pm S\bar{x}$	<i>S</i>
Nephrectomized	500	900.5 ± 5.0	111.9
Controls	500	842.5 ± 4.4	98.5
<i>T</i> -test	<i>t</i>	<i>p</i>	
Controls/nephrectomized	8.78	<0.001	

By Student's test it is demonstrated that the increase of deoxyribonucleic acid after nephrectomy is highly significant. We therefore conclude that the increase of the mitotic activity produced in the tubuli contorti of the kidney by compensatory hypertrophy after contralateral nephrectomy is correlated with an increase of the deoxyribonucleic acid content of the interphasic nuclei.

This investigation was aided by a grant from the Belgian National Foundation for Scientific Research.

J. FAUTREZ
G. CAVALLI
E. PISI

Department of Human Anatomy,
and

Belgian Centre of Normal and
Pathological Growth,
University of Ghent.

Dec. 14.

- ¹ Alfert, M., and Swift, H., *Exp. Cell Res.*, **5**, 455 (1953). Boivin, A., Vendrely, R., and Vendrely, C., *C.R. Acad. Sci., Paris*, **226**, 1061 (1948). Pollister, A. W., Swift, H., and Alfert, M., *J. Cell. and Comp. Physiol.*, **38**, 101 (1951). Swift, H., *Proc. U.S. Nat. Acad. Sci.*, **36**, 643 (1950). Swift, H., *Phys. Zool.*, **23**, 169 (1950).
- ² Govaert, J., *C.R. Soc. Biol.*, **147**, 1494 (1953). Leuchtenberger, C., and Schrader, A., *Proc. U.S. Nat. Acad. Sci.*, **38**, 49 (1952). Roels, H., *Nature*, **174**, 514 (1954).
- ³ Lison, L., and Pasteels, J., *C.R. Assoc. Anat.*, **37**, 375 (1950).
- ⁴ Lison, L., *Acta Anat.*, **10**, 333 (1950).

Synthesis of Peptides by Aminolysis of Nitrophenyl Esters

THE aminolysis of esters has already played a part in early attempts at peptide synthesis, as in the works of E. Fischer¹. Fischer recognized that methyl esters react more readily than ethyl esters. Recently, H. Brockmann and H. Musso² applied methyl esters of amino-acids to the preparation of peptides. The more reactive esters were not used, though the work of M. Gordon, J. G. Miller and A. R. Day³ shows that the speed of aminolysis of vinyl, and especially phenyl, esters of fatty acids is several magnitudes greater than that of the ethyl or methyl esters.

We have investigated the action of the phenyl ester of a protected amino-acid (the phenyl ester of phthalylglycine) on the ethyl ester of glycine, and found that in benzene solution at room temperature, after some days, the ethyl ester of phthalylglycine could be isolated in good yield. Th. Wieland and co-workers⁴ used the thiophenyl esters for the same purpose, their view being that the thio-acids, which readily form amides, should be employed in this case. They used thiophenyl esters only, because they were not able to synthesize the amino-thio-acids at that time. In his more recent work, Th. Wieland reports results obtained with thio-acids since prepared by him.

We believe that Wieland in this work with thiophenyl esters is perhaps not quite correct in emphasizing their character as thio-acid derivatives. We think rather that their reactivity is due to the fact that they are phenyl esters. In recent experiments, we have examined the esters of nitrophenols, which contain a phenolic hydroxyl group with a hydrogen of greater degree of dissociation, and it was found that the speed of aminolysis of the nitrophenyl esters is much greater than that of the phenyl ester and even than that of the thiophenyl ester. Table 1 shows the relative reactivities of the phthalylglycine esters at the boiling point of benzene.

Table 1

Phthalylglycine ester	Per cent transformation in 20 min.	Phthalylglycine isolated (per cent of theoretical)
Phenyl ester m.p. 123–124° C.	26.5	2.6
Thiophenyl ester m.p. 103–104° C.	47.5	30.8
<i>o</i> -Nitrophenyl ester m.p. 169–171° C.	90.0	76.0
<i>m</i> -Nitrophenyl ester m.p. 160–161° C.	97.5	82.7
<i>p</i> -Nitrophenyl ester m.p. 180–181° C.	95.0	75.2

The dinitrophenyl ester of phthalylglycine (m.p. 217° C.) in dioxane solution and ethylglycinate react rapidly with evolution of heat.

In our opinion the phenyl esters, especially the nitrophenyl esters, deserve further attention. They are less reactive than the acid chlorides, the acid azides or the mixed anhydrides; but that is often an advantage. For example, if there are free hydroxyl and amino groups simultaneously present (tyrosine, serine), it seems desirable to prepare first the well-defined nitrophenyl esters and then proceed to the selective acylation of the NH₂ group. Harington and Pitt Rivers⁵, in their synthesis of S-benzyl-N-carbobenzoyloxy-cysteine tyrosine, first protect the hydroxyl group of tyrosine and then add to it the protected cysteine by Curtius's method. Thus the synthesis required ten steps, in place of which the same protected peptide could be obtained more simply and in good yield through the reaction of S-benzyl-N-carbobenzoyloxy-cysteine-*p*-nitrophenyl ester (m.p. 84° C.) with ethyl tyrosinate, followed by saponification of the ethyl ester group.

M. BODÁNSZKY

Research Institute of the
Pharmaceutical Industry,
Budapest.
Nov. 29.

¹ Fischer, E., *Ber.*, **39**, 453 (1906). Fischer, E., and Suzuki, V., *Ber.*, **38**, 4173 (1905).

² Brockmann, H., and Musso, H., *Ber.*, **87**, 581 (1954).

³ Gordon, M., Miller, J. G., and Day, A. R., *J. Amer. Chem. Soc.*, **70**, 1946 (1948).

⁴ Wieland, Th., Schäfer, W., and Bokelmann, E., *Ann.*, **573**, 99 (1951).

⁵ Harington, C. R., and Pitt Rivers, R. V., *Biochem. J.*, **38**, 417 (1944).

Identification of the Protein Fraction of Human Serum containing the Thyrotropic Hormone

AFTER paper electrophoresis at pH 8.6 in a veronal-sodium buffer of a purified bovine hypophyseal thyrotropic hormone preparation, the hormonal activity was found to move with the same speed as the β -globulins of human serum under similar conditions. The thyrotropic hormone assay was carried out by the iodine-131 accumulation test in mice treated with iodocasein¹.

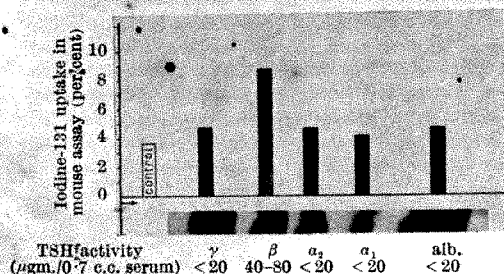


Fig. 1. Identification of thyrotropic hormone activity in human serum protein fractions obtained by paper electrophoretic separation

Cohn² has stated that the thyrotropic hormone activity in human serum is present in the β -globulin fraction. However, so far as we know, no evidence supporting this statement has yet been published. Therefore we decided to study the distribution of thyrotropic hormone in the various serum protein fractions more fully. Fractionation of the serum was carried out at -5°C ., using ethanol as precipitating agent, as described by Cohn *et al.*³. It was observed that in all cases in which thyrotropic hormone activity was demonstrable, it was present in the fraction IV-4, which contains, apart from some albumin, most β -globulin and α -globulin. Our results will be published in detail elsewhere.

Recently, we encountered a serum with an extremely high thyrotropic hormone content equal to about 12 mgm. U.S.P. arbitrary standard (= 120 Junkman-Schoeller units) in 100 ml. serum. This enabled us to identify by paper electrophoresis the fraction containing the active principle. Localization of the various protein fractions was carried out by staining with naphthalene black one of the strips. Other strips which had run simultaneously were cut up into corresponding pieces, and the thyrotropic hormone activity of the pooled fractions was determined after elution, dialysing and freeze-drying.

The results obtained are shown in Fig. 1. From them the conclusion seems to be justified that the thyrotropic hormone activity of human serum can only be demonstrated in the β -globulin fraction.

L. D. F. LAMEIJER
A. A. H. KASSENAAR
A. QUERIDO

Department of Clinical Endocrinology
and Diseases of Metabolism,
University Hospital,
Leyden, Dec. 8.

¹ Querido, A., Kassenaar, A. A. H., and Lameijer, L. D. F., *Acta Endocrin.*, 12, 335 (1953).

² Cohn, E. J., *Amer. Scientist*, 33, 61 (1945).

³ Cohn, E. J., Strong, L. E., Hughes, jun., W. L., Mulford, D. J., Ashworth, J., Mellin, M., and Taylor, H. L., *J. Amer. Chem. Soc.*, 68, 459 (1946).

Adsorption as a Major Phenomenon in the Concentration of Gonadotrophins by Ultrafiltration

DURING a study undertaken to evaluate the ultrafiltration method for concentration of gonadotrophic hormones from urine¹, we investigated the role of adsorption in this procedure. It is well known that adsorption participates in ultrafiltration². In his article Gorbman suggests the possible importance of adsorption in the method of isolation of gonadotrophic hormones. Grabar (personal communication, 1950) reported adsorption of urinary

gonadotrophic hormones when urine was allowed to drip through a nitrocellulose column. No quantitative results, however, seem to have been reported in the literature so far.

The methods used for ultrafiltration and bioassay have been described elsewhere³. In general, the Gorbman ultrafiltration technique was used with some modifications, the main one being adjustment of urinary pH to 5, prior to ultrafiltration. The immature mouse uterine weight bioassay was used, following the method of Klinefelter *et al.*⁴.

For interpretation of results, the average of the logarithms of uterine weights (in mgm.) of groups of mice (y) were used rather than the average weights in milligrams; thus permitting calculation of the standard error T_y between y 's from different groups, this value being 0.119 when five mice per group were taken.

In shaking-experiments, collodion filters (diameter approximately 17 cm.), prepared as usual for ultrafiltration, were shaken with 500 ml. of postmenopausal urine collections, preserved in a cool place and the gonadotrophic hormone content of which was fairly well known. Urine was shaken at room-temperature (a cold room was not available) at a rate of approximately 120 per min. When shaking was completed, filters were processed as after ultrafiltration; for example, the collodion was dissolved in alcohol-ether, the precipitated and centrifuged residue containing gonadotrophic activity dried and the activity of extracts tested by bioassay. The remaining urine was ultrafiltered in order to determine the amount of gonadotrophic hormone left behind. In control experiments an identical aliquot of the same specimen of urine was processed by ultrafiltration only. Bioassays of extracts from the same urine specimen were carried out at the same time in order to avoid daily variations in uterine response that had been previously shown to be significant.

In preliminary studies urine was shaken with nitrocellulose; only minimal amounts of gonadotrophic hormone appeared to be adsorbed. When urine was shaken with one collodion filter for five minutes, no adsorption to the filter was demonstrated. However,

Table 1. ADSORPTION OF GONADOTROPHINS TO COLLODION FILTERS SHAKEN WITH URINE

Exp.*		Shaking		Ultrafiltration	
		1st hr.	2nd hr.	filtrate after shaking	control urine
a	Coll. 1-2% Ph. 5.5	1 filter	1 filter		
	Level $U^\dagger$	400 200	96 12	10	400 200
	Yield ‡	1.07 1.01	0.95 1.66	1.09	1.57 1.65
b	Coll. 1-2% Ph. 5.3	1 filter	2 filters	***	
	Level U	448 224	168 28	36 6	448 224
	Yield	0.98 1.11	0.92 1.44	0.90 0.80	1.07 1.63
c	Coll. 2.4% Ph. 5.3	1 hour 2 filters			
	Level U	240	120	16	380 240
	Yield	0.95	1.44	0.68	0.77 1.21

* Groups of five mice, strain MAC, were injected with the same dose of extract, except in groups marked **, where three mice per dose were used.

† Unit-level per 24 hr. urine specimen.

‡ y = average log uterine weight (mgm.) in each group.

§ + = more than minimum quantity of gonadotrophic hormone present as demonstrated by y for the number of animals used. - = less than that. For statistically analysed criteria, see Van Gilse (ref. 3).

after shaking the urine for at least one hour, a great amount of gonadotrophic activity was present in the final filter extract. Further experiments were carried out using one half, one, or two filters, prepared from 1.2, 1.8 or 2.4 per cent collodion solution per 500 ml. of urine. The results are summarized in Table 1.

It appears from the results that maximal adsorption was achieved when urine was shaken with two 2.4 per cent collodion filters for one hour, or with three 1.2 per cent filters for two hours (Exps. c and b). In both instances no gonadotrophic activity was demonstrated in the urine after being shaken. In none of the experiments, however, was there exactly the same quantity of gonadotrophic hormone activity as that present in the control urine, the minimum loss being an estimated 10–20 per cent.

Although our results are not sufficient to establish statistical calculation, it can be concluded that 80–90 per cent of the gonadotrophic hormone in urine concentrated by ultrafiltration is adsorbed on the filters. By improving the technique of adsorption and by changing shaking conditions it may be possible to improve the yield.

It is significant that, from these experiments, adsorption plays a major part in the concentration of gonadotrophins from urine by so-called ultrafiltration.

I am indebted to Dr. P. Grabar for his suggestions, to Prof. A. Querido and Dr. A. A. H. Kassenaar for interest in the experiments.

HENRIETTE A. VAN GILSE*

Department of Clinical Endocrinology
and Diseases of Metabolism,
University Hospital, Leyden.
Dec. 1.

* Present address: Rotterdam Radiotherapeutisch Institute, 323 Bergweg, Rotterdam.

¹ Gorbman, A., *Endocrin.*, **37**, 177 (1947).

² Bechhold, H., "Die Kolloide in Biologie u. Medizin", 111 (Dresden, 1919). Elford, W. J., *Proc. Roy. Soc.*, **B**, 112, 384 (1933). Grabar, P., "Études Physicochimiques Appliquées à la Biologie", 90 (Paris, 1943).

³ Van Gilse, H. A., thesis (Leyden, 1953). Van Gilse, H. A., Nass, C., and Kassenaar, A. A. H. (to be published).

⁴ Klinefelter, H. F., Albright, F., and Griswold, G. C., *J. Clin. Endocrin.*, **3**, 529 (1943).

Gonadotrophic Action of Corticosteroids in *Xenopus laevis* and its Isolated Ovary

It has been shown that progesterone¹ and certain related steroid compounds such as testosterone, methyltestosterone, androstenedione² and 11-deoxycorticosterone³ will cause ovulation when injected into *Xenopus laevis*. Ovulation was induced also in the excised ovary suspended in frog's Ringer solution by the addition of progesterone¹, testosterone and androstenedione⁴.

It has now been found that the following additional corticosteroids will induce ovulation when injected either into the dorsal lymph sac or intraperitoneally in 5–10 mgm. doses: corticosterone, 11-dehydrocorticosterone, cortisol and cortisone.

These corticosteroids and also 11-deoxycorticosterone caused extrusion of numerous ova when an excised ovary was suspended in 20 ml. of frog's Ringer to which 1 mgm. of the steroid was added. The results indicate that 11-deoxycorticosterone is as potent as progesterone but much more potent than the other corticosteroids. Corticosterone and 11-dehydrocorticosterone are more active than cortisol and cortisone.

All the experiments were performed during October and November, that is, just after the end of the breeding season, with animals freshly brought in from the ponds.

Since the competition of these experiments, 17-hydroxy-11-deoxycorticosterone became available, and it was found that it had the same gonadotrophic action as the other corticosteroids. We wish to thank Messrs. Ciba, Ltd., Basle, for a supply of this steroid.

One of us (A. C. J. B.) is in receipt of grants from the Union Government and from the Netherlands Organization for Pure Research (Z.W.O.).

A. C. J. BURGERS

H. ZWARENSTEIN

Dept. of Physiology and Pharmacology,
University of Cape Town.
Dec. 6.

¹ Zwarenstein, H., *Nature*, **139**, 112 (1937).

² Shapiro, H. A., *S. Afr. J. Med. Sci.*, **4**, 21 (1939).

³ Sapeika, N., *S. Afr. J. Med. Sci.*, **8**, 115 (1943).

⁴ Shapiro, H. A., and Zwarenstein, H., *J. Physiol.*, **89**, 38P (1937).

Grafting and Hybridization Experiments in the Genus *Trifolium*

Trifolium is a genus displaying very little inter-specific compatibility, and any methods which would make possible species hybridization are worthy of trial. Michurinist geneticists in the U.S.S.R. claim that 'vegetative rapprochement' can be used for making distant crosses compatible. This led us to explore the possibilities of applying such grafting methods in the genus *Trifolium*. There is an abundance of literature available on this subject, but only a few examples relating to this work will be cited here.

The first record of grafting in the clovers, known to us, is that of Biffen¹ when he "tested the possibility of obtaining improved varieties of cultivated plants by employing the process of grafting". Recently, Hely, Bonnier and Manil² grafted *Trifolium repens* on to *T. ambiguum* and achieved good success. Again, Dyba³ has shown that by grafting prior to crossing it has been possible to obtain interspecific and inter-generic hybrids of several grasses and leguminous forage plants. A method of embryo grafting has also been used for overcoming incompatibility, but this is not applicable to clover because of the small size of the seed.

In the present work, which was begun in Svalöf in 1950 and continued at Aberystwyth since then, seven *Trifolium* species, considered to be of agronomic importance, were chosen, namely, *T. pratense*, *T. medium*, *T. repens*, *T. hybridum*, *T. incarnatum*, *T. alexandrinum* and *T. subterraneum*. These were grafted interspecifically in all combinations, and intraspecific grafts were also made, giving forty-nine groups in all. Grafting was carried out in the spring when a shoot about 1 in. long was taken and prepared by slicing the base into a wedge shape. All leaves which had unfolded were removed, thereby reducing transpiration. This scion was then inserted into a split made in the node of the stock, and bound in position with a narrow band of wet raffia, or by using an auto-adhesive bandage. The treated plants were retained in a glass-topped frame covered with fine muslin. A high humidity was maintained, and the plants were left in the frame for about three weeks until the grafts had established themselves. Some of the grafts produced roots; these were removed,

so that the scion became totally dependent on the stock.

The percentage success of grafting in the first years (1950 and 1951) was rather low, and some of the graft combinations did not succeed at all. In 1952 seedling grafts where the scion was inserted into the split crown of the stock were tried and found to be highly successful, a 90 per cent success being often achieved between compatible species.

Before making the crosses of stock $\times$ scion and the reciprocal, it was important to know if pollen production was affected by grafting. There proved to be no significant differences between the measurements and counts of the pollen grains in the grafted and ungrafted plants.

As a result of crosses made in 1950 and 1951, no hybrid seed was obtained; but it became evident that one effect of grafting was to increase the self-fertility of the grafts. This is possibly due to wounding of the tissues, and the self-fertility may be a form of compensation for the plant. Further observations are being made together with an examination of the methods of emasculation.

In some of the attempted hybridizations, the pollen did not germinate on the style of the other species. To facilitate pollen germination, the stigma was painted with a solution of the hormone β -naphthoxy-acetic acid⁴, which acted as a substrate for the pollen; germination was then successfully effected in some cases. In order to trace the growth of pollen tubes down the style, the pollen tubes were stained with cotton blue in lactophenol. However, it was very difficult to trace the entry of the pollen tube into the ovule. In an endeavour to determine whether fertilization had taken place, different ovules of the same head were measured daily after pollination. Some of the ovules were observed to increase in size, and after about eight days it was possible to detect an embryo on dissecting the ovule. Quite frequently, however, the ovules shrivelled after ten days, and it seemed that the developing hybrid embryo could not grow on the endosperm.

As a next step in these studies it is proposed to attempt to salvage these embryos before abortion and to grow them in culture. Up to the present, no mature hybrids have been successfully produced; but there is evidence of fertilization in some of the species combinations.

On comparing the results of crossing ungrafted plants with those of attempted crosses between stock and scion, there seemed to be little difference as judged by the number of incipient hybrid embryos; in those inter-species combinations where grafting did not succeed, there was likewise no evidence of incipient embryo development. It appears, therefore, that a correlation exists between the success of grafting and the success of hybridization, or at least fertilization. In a genus like *Trifolium*, where there are about 250 species, it is obviously impracticable to make all the possible combinations by hybridizing. The grafting technique can thus possibly serve as a sieving-out process, since it would appear from these studies that only those species which graft successfully will be likely to hybridize. This correlation between success of grafting and of interspecific hybridization has been noted by workers on *Theobroma* species⁵, and they suggest that possibly the success of hybridization and grafting have a common physiological basis.

The work on increased self-fertility as a result of grafting is being continued at Svalöf, and the work

on hybridization and embryo culturing is in progress at Aberystwyth, detailed results of which will be published elsewhere.

ALICE M. EVANS

Welsh Plant Breeding Station,
Aberystwyth.

THORE DENWARD

Swedish Seed Association,
Svalöf, Sweden. Dec. 21.

¹ Biffen, R., *Ann. Bot.*, 174 (1902).

² Hely, F. W., Bonnier, Ch., and Manil, P., *Nature*, 171, 884 (1952).

³ Dyba, A. S., *Selekcija i Semenovodstvo* (Breeding and Seed Growing), 6, 50 (1949).

⁴ Crane, M. B., and Marks, E., *Nature*, 170, 1017 (1952).

⁵ Addison, G., and Tavares, R., *Evolution*, 6, 380 (1952).

Shikimic Acid as a Precursor in Lignin Biosynthesis

THE role of shikimic acid and related compounds in the biosynthesis of the aromatic ring by mutants of *E. coli* has recently been the subject of extensive study by Davis and his associates¹. Their work has indicated that shikimic acid is an important precursor of the aromatic structure in this organism. The reaction sequence by which this compound is aromatized is still not fully understood, but it is believed² that prephenic acid is one of the intermediates and that the first aromatic compound formed is phenylpyruvic acid. The above findings have raised the question of the existence of a similar biosynthetic pathway in higher plants, and we have now investigated this possibility during current studies on the origin of lignin, one of the principal aromatic plant constituents.

Early work on the chemistry of lignin³ led to theories that it is a polymer of some unit having a phenylpropane skeleton (a C-6, C-3 structure). Recently, Freudenberg and his co-workers⁴ have adduced further evidence in support of this concept by their finding that coniferyl alcohol undergoes polymerization to a lignin-like substance in the presence of oxidizing enzymes from *Araucaria*. Siegel⁵ has reported that eugenol fed to *Phaseolus vulgaris*, and eugenol and ferulic acid given to *Elodea densa*, were effective in stimulating the synthesis of substances giving characteristic lignin tests. For comparison with shikimic acid as a lignin precursor we have, therefore, chosen a C-6, C-3 aromatic compound, L-phenylalanine, which is especially suitable because of its widespread occurrence and close structural and metabolic⁶ relationship to phenylpyruvic acid. We have also studied protocatechuic acid, as a representative of naturally occurring aromatic compounds with a one-carbon side-chain.

Wheat (*Triticum vulgare* Vill., var. Thatcher) and ash-leaved maple (*Acer negundo* L., var. *interius*) were the plants used in these experiments. Labelled shikimic acid was prepared by fermentation of randomly carbon-14-labelled glucose with *E. coli* mutant 83-24, provided through the courtesy of Dr. Bernard Davis. Randomly labelled L-phenylalanine was purchased from Atomic Energy of Canada, Ltd., and protocatechuic acid was synthesized by demethylation of carboxyl-labelled vanillic acid⁷ with hydrogen iodide. These compounds (0.10–0.135 m. mole) were fed by absorption of a small volume (1 ml.) of their aqueous solutions through the cut ends of the stems or twigs. After transfer to water, the plants were allowed to metabolize during 24 hr. beside a

Table 1. UTILIZATION OF LABELLED COMPOUNDS IN LIGNIN BIOSYNTHESIS

Plant	Compound administered	$\mu\text{C/m.mole}$ of administered compound (a)	$\mu\text{C/m.mole}$ of vanillin (V) or syringaldehyde (S) (b)	Dilution (a/b)
Wheat	Shikimic acid	24.4	V 0.525	46.5
			S 0.596	41.0
	L-Phenylalanine	20.8	V 0.338	61.5
Maple	Shikimic acid	24.4	S 0.421	49.5
			V 0.112	220 (210*)
			S 0.072	339 (326*)
	L-Phenylalanine	31.3	V 0.303	105
	Protocatechuic acid†	115.0	S 0.120	260
			V negligible	—
			S negligible	—

* Corrected for dry weight of plant to enable direct comparison with the phenylalanine figures. Dry weight of wheat, 1.2–1.4 gm.; of maple, 2.7–4.0 gm.

† Fed as the potassium salt at pH 6.

north window at 20–25°C. They were then dried and ground, and the cell-wall fraction was prepared and oxidized with nitrobenzene essentially as reported earlier⁸. Vanillin and syringaldehyde from the oxidation were isolated as the *m*-nitrobenzoylhydrazones following their separation on Whatman 3 MM paper sheets⁹. The determination of carbon-14 was carried out by wet combustion of the samples and analysis of the carbon dioxide in a gas-phase counter¹⁰.

The last column of Table 1 shows the dilutions in the specific activity of the different labelled precursors during their conversion to lignin. Because of differences in the weight of the plant material and in conditions of growth prior to the experiment, the results cannot be compared quantitatively between the two species; but they are comparable within each species. It can be seen that the efficiency with which shikimic acid is converted to the vanillin- and syringaldehyde-yielding lignin residues is of the same order as that of phenylalanine. In contrast, protocatechuic acid, an aromatic compound which resembles vanillin in the position of its substituents, is not measurably transformed to lignin. It appears, therefore, that shikimic acid is readily convertible by the plant to some compound closely allied to phenylalanine, which is a lignin precursor. The results (unpublished) which we have obtained with other C-6, C-1 aromatic compounds (benzoic, *p*-hydroxybenzoic and anisic acids), as well as the above results on protocatechuic acid, lead to the conclusion that this transformation probably does not involve an aromatic compound possessing only one side-chain carbon.

In view of the above findings, it seems likely that a pathway of aromatic biosynthesis similar to that found by Davis *et al.* in *E. coli*¹¹, involving prephenic and phenylpyruvic acids, also exists in plants. The sequence of reactions in this stage of lignin formation would appear to be: (1) attachment of a three-carbon side-chain to a non-aromatic ring, (2) aromatization and (3) substitution of the ring.

The demonstration that shikimic acid can serve as an aromatic precursor in *Triticum* and *Acer* raises the question of the ubiquity of this compound among higher plants. It is of interest that Hasegawa and co-workers¹¹ have recently shown its occurrence in forty-nine species, indicating considerably more widespread distribution than was previously believed.

Further details of this and related work will be submitted to the *Canadian Journal of Biochemistry and Physiology*. We wish to thank Dr. R. Y. Stanier, of the University of California, who suggested testing

shikimic acid, Drs. F. J. Simpson and Ping Shu, who carried out the fermentation, and Messrs. F. M. Clare and John Dyck, who assisted with the analyses.

STEWART A. BROWN
A. C. NEISH

National Research Council,
Prairie Regional Laboratory,
Saskatoon, Saskatchewan.
Dec. 19.

¹ Davis, B. D., *J. Biol. Chem.*, **191**, 315 (1951). Salamon, I. A., and Davis, B. D., *J. Amer. Chem. Soc.*, **75**, 5567 (1953). Weiss, U., Davis, B. D., and Mengioli, E. S., *J. Amer. Chem. Soc.*, **75**, 5572 (1953).

² Weiss, U., Gilvarg, C., Mingioli, E. S., and Davis, B. D., *Science*, **119**, 774 (1954).

³ Brauns, F. E., "Chemistry of Lignin", 628 (Academic Press, Inc., New York, 1952).

⁴ Freudenberg, K., Reznik, H., Boesenberg, H., and Rasenack, D., *Ber.*, **85**, 641 (1952).

⁵ Siegel, S. M., *Physiol. Plant.*, **6**, 134 (1953); **7**, 41 (1954).

⁶ Rowsell, E. V., *Nature*, **168**, 104 (1951).

⁷ Kratzl, K., and Billek, G., *Holzforschung*, **7**, 66 (1953).

⁸ Brown, S. A., Tanner, K. G., and Stone, J. E., *Can. J. Chem.*, **31**, 755 (1953). Brown, S. A., and Neish, A. C., *Can. J. Biochem. and Physiol.*, **32**, 170 (1954).

⁹ Stone, J. E., and Blusdell, M. J., *Anal. Chem.*, **23**, 771 (1951).

¹⁰ Buchanan, D. L., and Nakao, A., *J. Amer. Chem. Soc.*, **74**, 2389 (1952).

¹¹ Hasegawa, M., Yoshida, S., and Nakagawa, T., *Kagaku*, **24**, 421 (1954).

Internal Seed Disinfection by an Antibiotic from *Streptomyces rimosus*

INVESTIGATIONS have been carried out on the systemic fungicidal action of substances from cultures of several fungi (including Actinomycetes) and bacteria. A suspension, obtained from a culture of *Streptomyces rimosus* from the Centraal Bureau voor Schimmelcultures at Baarn, Holland, behaved as a potent antibiotic against some bacteria and fungi, for example, *Ascochyta pisi* and *Mycosphaerella pinodes*.

These fungi are, in the Netherlands, especially in wet years, common parasites in pea seeds. External seed treatment is ineffective because of the deep-seated nature of infection. The above-mentioned suspension was active against both of them in pea seeds.

Seeds of peas, heavily infected with *Ascochyta pisi*, were used for testing the fungicidal properties of the antibiotic substances and their ability to penetrate into the seeds. The seeds were soaked in the solution or the suspension to be tested for different periods. Then the seeds were placed on wet filter paper in a moist chamber at room temperature. The effect of the treatment was determined after one week, by counting the number of seeds developing *Ascochyta* mycelium on the seed coat.

Experiments were carried out with a suspension obtained by grinding a culture of *Streptomyces rimosus*, grown on agar, in a Waring blender, and mixing this mass with a definite quantity of water. In the following, this suspension is referred to as 'rimag'. Soaking infected pea seeds in 'rimag' for 18 hr. reduced considerably the number of seeds developing *Ascochyta pisi* mycelium (Table 1).

Table 1. PERCENTAGES OF HEAVILY INFECTED SEEDS DEVELOPING *Ascochyta* MYCELIUM AFTER SOAKING FOR 18 HR. IN 'RIMAG' OR WATER

Variety	Soaked in	No. of seeds	Per cent seeds developing <i>Ascochyta</i> mycelium
Dopper Eminent	'rimag'	120	8.5
Dopper Eminent	water	120	77
Servo	'rimag'	200	6
Servo	water	200	60

Table 2. EMERGENCE OF HEALTHY AND INFECTED SEEDS, PLANTED IN STERILIZED SOIL, AFTER SOAKING IN 'RIMAG' OR WATER FOR 18 HR.

Variety	Soaked in	No. of seeds	Emergence
Rondo, healthy	'rimag'	100	93
Rondo, healthy	water	100	90
Dopper Eminent, diseased	'rimag'	100	66
Dopper Eminent, diseased	water	100	66

After a week, the length of the rootlets of the 'rimag'-treated seeds in this test was the same as for seeds treated with water. However, when 'rimag' was prepared from a culture older than two weeks, there was evidence of toxicity.

Soaking healthy or infected seeds in 'rimag' for 18 hr. did not decrease emergence in sterilized soil (Table 2).

To prove that an antibiotic substance in 'rimag' penetrated into the seeds, pieces of the inside of treated seeds were placed in Petri dishes on agar, seeded with a bacterium that is inhibited by 'rimag' *in vitro*. The inhibition zones caused by these pieces indicated that at least one antibiotic component of the suspension had penetrated into the seeds.

It was also demonstrated that *Mycosphaerella pinodes*, present within seeds of peas, is killed by treatment with 'rimag'.

According to the literature, *Streptomyces rimosus* produces at least two antibiotics, namely, terramycin and rimocidin. Terramycin, which is not reported to have any fungicidal activity, did not inhibit *Ascochyta pisi* either *in vitro* or *in vivo*. Rimocidin is known as a fungicide¹, but systemic action of this compound has not been reported.

By the courtesy of Chas. Pfizer and Co., Inc., who sent us crude rimocidin (760 µgm./mgm.), this antibiotic was tested. It was demonstrated that rimocidin penetrates into pea seeds and has fungicidal activity against *Ascochyta pisi* both *in vitro* and *in vivo*. Soaking in a solution of rimocidin at concentrations of 25 and 50 p.p.m. decreased the number of seeds with mycelial growth of *Ascochyta pisi* appreciably, and treatment with a solution of 100 p.p.m. gave nearly complete control (Fig. 1).

Soaking for 18 hr. in rimocidin at 200 p.p.m. did not depress germination and emergence of the seeds in sterilized soil. The growth of plants from these seeds was not impaired. This indicates that there is a considerable difference between the fungicidal and the phytotoxic concentrations of this antibiotic.

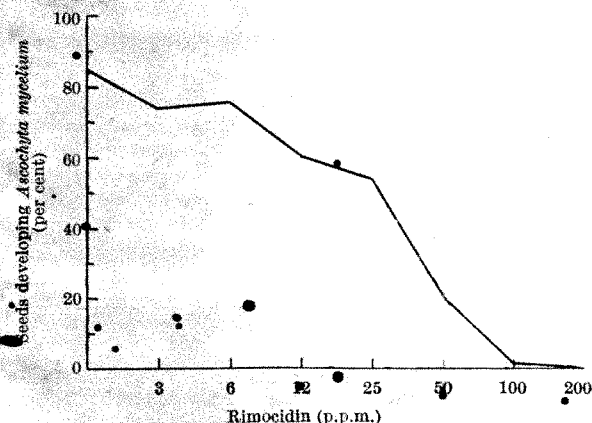


Fig. 1. Percentages of seeds, var. Dopper Eminent, developing *Ascochyta* mycelium after soaking for 18 hr. in various concentrations of rimocidin.

I am indebted to Chas. Pfizer and Co., Inc., for providing the rimocidin, and to Miss E. Goedbloed for assistance.

J. DEKKER

T.N.O.-Z.W.O. Research Unit
for Internal Therapy of Plants,
Laboratory of Phytopathology,
Agricultural University,
Wageningen, The Netherlands.
Dec. 6.

¹ Davisson, J. W., Tanner, F. W., Finlay, A. C., and Solomons, I. A., *Antibiotics and Chemotherapy*, 1, 239 (1951).

A Marine Bacteriophage

ONE of the main difficulties in the study of marine bacteria, and particularly of those types which constitute the flora of fresh and spoiling fish, is that of identification and classification. This is due to the negative results given by these bacteria in most common biochemical tests. It was considered that the use of bacteriophage might help with this difficulty, and consequently attempts were made to isolate bacteriophages active against certain marine bacteria associated with fish, and particularly against certain luminous bacteria probably identical with *Photobacterium phosphoreum* (*Bacterium phosphoreum* Bergey¹). These luminous bacteria have been shown by various workers to constitute a considerable part of the flora of many species of fish².

Various methods of isolation were attempted, and the following one proved successful. To 100 ml. of quadruple strength sea-water 'Lemco' broth ('Lemco' 4 per cent, peptone 4 per cent, aged sea-water 75 per cent, tap-water 25 per cent, pH 7.6) were added 300 ml. of sea-water taken approximately ten miles east-south-east of Aberdeen, together with 8 ml. of an overnight sea-water 'Lemco' broth culture of each of four different strains of luminous bacteria. This was incubated at 20° C. for 48 hr., Seitz-filtered, and the filtrate tested for lytic action on the surface of sea-water 'Lemco' agar plates previously inoculated with the appropriate bacterial strain. This method of isolation was repeated many times with various bacterial strains. Bacteriophage was isolated in only one case. The bacteriophage was purified by several single-plaque isolations and increased in titre by plate lysis.

As the bacteriophage was obtained from a mixed culture, that is, four strains grown together, there was a possibility that it originated, not from the sea-water, but from a lysogenic strain. This possibility was disproved by testing the strains for lysogenicity by Fisk's³ method; none was lysogenic. The four strains were also grown together in further samples of sea-water under identical conditions to the experiment which resulted in bacteriophage. This failed to yield further bacteriophage. It thus appears that sea-water far from land does contain bacteriophage, but only sparsely.

Several workers have examined sea-water for the presence of bacteriophages, and although bacteriophages active against various enterobacteria have been isolated from polluted sea-water, none has been isolated which is active against marine bacteria⁴. Also, this is only the second⁵ reported isolation of a bacteriophage active against luminous bacteria.

Fig. 1 shows lysis of several strains of luminous bacteria, one strain being resistant: (a) was taken by

Table 1

Time of exposure (min.)												Temp. ° C.
0	1	2	3	4	5	7½	10	12½	15	20	30	
+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	40
+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	45
+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	50

+++ , Confluent lysis ; ++ , confluent plaques ; + , many isolated plaques ; ± , few isolated plaques ; - , no lysis

artificial light and (b) is the same Petri dish photographed by the luminescence of the bacteria (exposure of 90 min., lens-object distance 50 cm., aperture f/8, Kodak P200 plate). It can be seen that the luminescence of the resistant secondary growth was in no way affected.

The question of which characteristics distinguish marine micro-organisms from related terrestrial forms is a much debated one, but such characteristics as the ability to grow at temperatures near 0° C., the preference for salinity in the range 3-4 per cent or at least as good growth in this range as at 0.5-1 per cent, and, in general, a lower heat tolerance than terrestrial forms, are generally accepted. The bacteriophage isolated possesses all these characteristics. It will cause lysis on a sea-water 'Lemco' agar medium at 0° C. It will not cause lysis on a tap-water 'Lemco' agar containing 0.5 per cent sodium chloride, although the host strain grows well on this medium. Addition of sodium chloride up to 2-3 per cent to the tap-water medium allows lysis to take place.

There have been several studies of the heat tolerance of bacteriophages, and in general it may be said that terrestrial ones are not appreciably inactivated by exposure in broth to 60° C. for 10-30 min. Indeed, some *coli*-phages are not inactivated at all by exposure to 65° C. Table 1 shows the inactivation of the marine bacteriophage in sea-water 'Lemco' broth.

Standard loopfuls were taken from the broth at the intervals indicated and tested for lytic activity on sea-water 'Lemco' agar plates. The original titre of the bacteriophage was such that a loopful of a 1 in 10,000 dilution gave confluent plaques. It can be seen that the marine bacteriophage is much less tolerant of heat than terrestrial bacteriophages.

The above characteristics confirm that the bacteriophage is of marine origin and support the thesis that there is a typical marine microbiological flora.

A more detailed study of the properties of this bacteriophage and its use in classification will be reported elsewhere.

This work was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research,
R. SPENCER

Humber Laboratory,
Food Investigation Organization
(Department of Scientific and
Industrial Research),
Hull.
Feb. 7.

¹ "Bergey's Manual of Determinative Bacteriology", 6th ed. edited by Breed, R. S., Murray, E. G. D., and Hitchens, A. P. (Williams and Wilkins Co., Baltimore, 1948).

² Spencer, R., *J. Gen. Microbiol.* (in the press).

³ Fisk, R. T., *J. Inf. Dis.* 71, 153 (1942).

⁴ ZoBell, C. E., "Marine Microbiology" (Chronica Botanica Co., Waltham, Mass., 1946).

⁵ Sonnenschein, C., *Zbl. Bakt.*, 2 Abt., 126, 297 (1932).

Enzymatic Production of Carbon Dioxide in Hevea Latex

EARLY investigators of *Hevea* latex were aware that fresh latex always contained considerable amounts of free carbon dioxide.

Van den Tempel in some recent analyses found 114 milliequivalents of carbon dioxide per litre of serum in old ammoniated latex and 66 milliequivalents in commercial concentrated latex. We do not, however, think it generally appreciated that latex contains an active 'carboxylase' system (no evidence has been obtained that pyruvic acid is the precursor of the carbon dioxide). At tapping, we have found fresh latex to contain about 20 milliequivalents of carbon dioxide per litre of serum; if the latex is allowed to stand at atmospheric temperature, this increases after 6 hr. to 85. The estimation of carbon dioxide was carried out by aspirating carbon dioxide-free air through latex acidified with hydrochloric acid and stabilized with 'Vulcastab LW', into standard baryta solution.

The carbon dioxide content plotted against the time after tapping follows a linear relationship, indicating an apparent zero-order enzymatic reaction. After 5-6 hr. the rate of formation falls off somewhat but the kinetics of the later reaction have not yet been followed. It might be expected that after six hours or so, bacterial activity would set in, and this would complicate the issue. The reaction virtually ceases at pH 8 (by addition of 0.03 per cent ammonia) and is almost entirely inhibited by 0.05-0.075 per cent of formaldehyde or 0.01-0.02 per cent of sodium fluoride. It now becomes very clear why the properties of preserved latex are so much affected by the interval which elapses between time of tapping

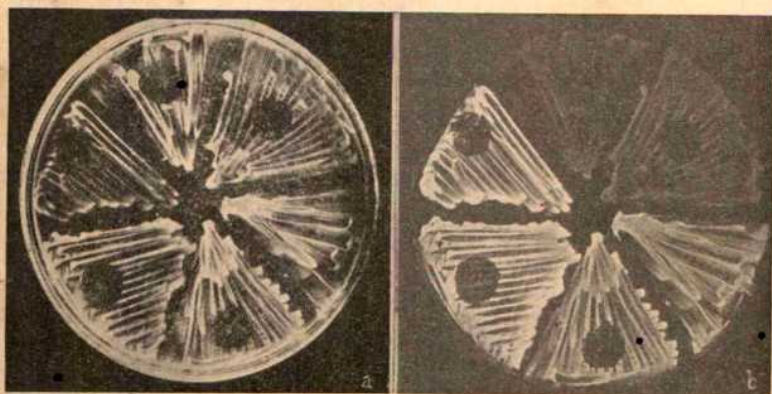


Fig. 1

and the time of preservation. We thank Dunlop Malayan Estates, Ltd., for permission to publish these preliminary findings.

F. J. PATON
H. M. COLLIER

Dunlop Research Centre,
Batang Malaka,
Negri Sembilan, Malaya.
Dec. 14.

The Protein from *Balanites aegyptica*

THE only reported study of the protein of *Balanites aegyptica* is an abstract from a thesis by Despujols¹, who showed the presence of two fractions, 70–75 per cent of balanine ("insoluble in water in the presence of salts") and 25–30 per cent of aegyptine (soluble under the same conditions). It was claimed that the two fractions can be separated by dialysis, but the use of salts did not give a complete separation. No details regarding the method of extraction of the protein from the nut were given. In this communication a brief ultracentrifugal study of a saline extract of the protein is presented.

The nuts of *Balanites aegyptica* from Sudan (lalob nuts) were shelled, ground and the oil removed with petroleum ether. Using a 1:10 meal:liquor ratio, the de-oiled meal, containing 8.6 per cent nitrogen, was extracted with 10 per cent (w/v) sodium chloride solution, the protein precipitated by saturation to 85 per cent with ammonium sulphate and purified by a similar reprecipitation from 10 per cent sodium chloride solution. The nitrogen content of the protein was 17.1 per cent and its partial specific volume 0.685 (± 0.005).

Examination of the protein after dialysis against phosphate buffer (ionic strength, $I = 0.5$, $pH = 8$) in the 'Spinco' Model *E* ultracentrifuge at *c.* 200,000 *g* showed the presence of two main components, of sedimentation constants (*s*) 12.3 and *c.* 2 *S* (Svedberg units, Fig. 1*a*). The fractions precipitating from a 10 per cent sodium chloride extract at between 0–40 and 40–85 per cent saturation with ammonium sulphate were redissolved in 10 per cent sodium chloride, reprecipitated and, after dialysis, were examined in the same buffer in the ultracentrifuge. Fig. 1*b* shows the sedimentation diagram of the 0/40 fraction, which consisted mainly of the $s_{12.3}$ component with a small amount of s_{18} and some s_2 component. The 40/85 fraction, on the other hand, contained most of the slowly sedimenting material, and also a small amount of s_8 material as well as the

$s_{12.3}$ component. The fractionation, however, was by no means sharp.

No appreciable changes in the sedimentation diagram of any of the fractions were observed on lowering the ionic strength to 0.05. Thus, dissociation-association reactions brought about by ionic strength changes, which are characteristic of some other proteins, appear to be absent in this system.

In the absence of sufficient published data, no correlation of the sedimenting components reported in this work with the fractions of Despujols has been attempted.

W. E. F. NAISMITH

'Ardil' Fibre Factory,
Imperial Chemical Industries, Ltd.,
Nobel Division,
Dumfries.
Dec. 16.

¹ Despujols, J., "L'Année Biologique", 24, 203 (1948).

Rabbit Fleas on Wild Rabbits and the Transmission of Myxomatosis

DURING the course of investigations into myxomatosis on the Heisker or Monach Isles, North Uist, it was suspected that the rabbit flea, *Spilopsyllus cuniculi* (Dale), was responsible for the carry-over of the disease during the winter of 1952–53. Laboratory experiments confirmed that the rabbit flea could transmit the disease, and this was also shown by Lockley¹. Since December 1953 a census of the flea population on wild rabbits has been carried out on an estate near Aberdeen, and the accompanying histogram (Fig. 1) illustrates the results.

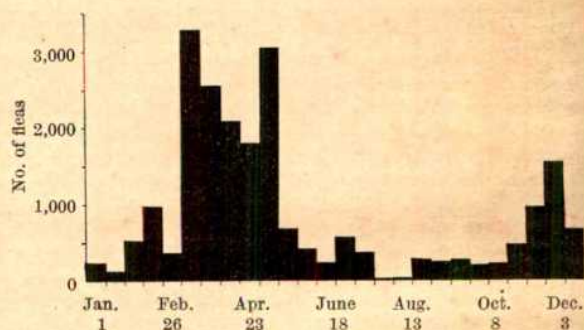


Fig. 1. Total number of fleas taken from twenty rabbits at fortnightly intervals

The census is being continued for a further period in order to establish whether or not the increase in the population during March and November is characteristic of this species.

It is of interest to record that it has been found that, under laboratory conditions at least, *Ixodes reduvius* can also be a vector of myxomatosis virus.

R. M. ALLAN

Entomology Department,
Marischal College,
Aberdeen.

P. L. SHANKS

Veterinary Investigation Department,
Mill of Craibstone,
Bucksburn,
Aberdeenshire.
Dec. 17.

¹ Lockley, R. M., *Vet. Rec.*, 65, No. 30 (1954).

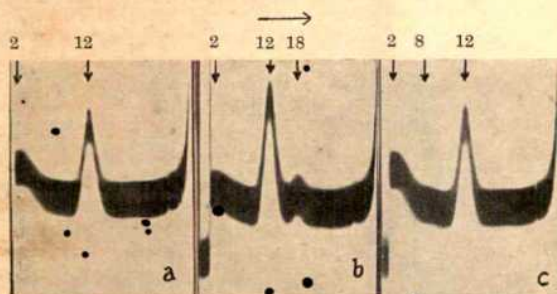


Fig. 1. Sedimentation diagrams of protein fractions from *Balanites aegyptica* in phosphate buffer, $I = 0.5$, $pH = 8$. Protein concentration 0.5 gm./100 ml. (a) 0/85 fraction; (b) 0/40 fraction; (c) 40/85 fraction. Numbers above peaks refer to rounded sedimentation constants in Svedberg units

FORTHCOMING EVENTS

Monday, April 18

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Annual General Meeting, 5.55 p.m.—Mr. G. L. Baldit: "The Development of a New Pesticide".

SOCIETY FOR GENERAL MICROBIOLOGY (at the Royal Institution, Albemarle Street, London, W.1), at 8 p.m.—Prof. O. B. van Niel (U.S.A.): "Natural Selection in the Microbial World" (Second Marjory Stephenson Memorial Lecture).

INSTITUTE OF METAL FINISHING (Joint meeting of the LONDON BRANCH AND ORGANIC FINISHING GROUP, at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. R. Tilney: "Electrostatic Painting Processes"; followed by a film on "Electrostatic Spraying".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Dr. E. B. Worthington: "East Africa and Her Neighbours".

Tuesday, April 19

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Measurement of Impulse Voltages and Currents with special reference to the Testing of Surge Diverters".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting, followed by three short papers on "Polyester Resins".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Prof. W. S. Hemp: "Thermoelectricity".

Tuesday, April 19—Wednesday, April 20

SOCIETY FOR GENERAL MICROBIOLOGY (at the Royal Institution, Albemarle Street, London, W.1)—Symposium on "Mechanisms of Microbial Pathogenicity".

Tuesday, April 19—Friday, April 22

UNIVERSITY OF MANCHESTER (at the University)—Symposium on "Astronomical Optics and Related Subjects".

Wednesday, April 20

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Annual General Meeting.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. K. F. Lane and Dr. J. M. Andrew: "A Method of Labour Turnover Analysis".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. G. H. Metson: "A Study of the Long-Term Emission Behaviour of an Oxide Cathode Valve".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mrs. M. W. Gardiner: "Notes on the Refraction Ring in Bubbles".

Thursday, April 21

ROYAL INSTITUTE OF CHEMISTRY (Joint meeting with the CHEMICAL SOCIETY, the INSTITUTE OF PETROLEUM and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Lecture Theatre, The University, Manchester), at 10.30 a.m.—Symposium on "Organo-Metallic Compounds".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. A. G. Gaydon, F.R.S., Mr. N. P. W. Moore and Mr. J. R. Simonson: "Chemical and Spectroscopic Studies of Blue Flames in the Auto-Ignition of Methane"; Mr. N. Gregory, Mr. J. T. Stuart and Mr. W. S. Walker: "On the Stability of Three-dimensional Boundary Layers with Application to the Flow due to a Rotating Disk".

INSTITUTE OF MINING AND METALLURGY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. F. A. Schaafelberger and Dr. T. K. Roy: "Separation of Copper, Nickel and Cobalt by Selective Reduction from Aqueous Solution"; Mr. H. A. Graves: "A Decade of Progress in Canadian Mining (1945-1954)—Part I".

LINNÆAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. Heslop Harrison, F.R.S.: "Natural Hybridization and its Consequences in British Dactyloctenidia".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. W. Shockley: Forty-Sixth Kelvin Lecture on "Transistor Physics".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Major Bo. K. O. Lundberg: "Aeronautical Research in Sweden".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Annual General Meeting.

Friday, April 22

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION GROUP (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Technical Training in North-West Germany".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Annual General Meeting; 7.30 p.m.—Chairman's Address.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ASSISTANT PHYSICIST (with an honours degree in physics, and previous experience in hospital physics) in the RADIO THERAPY AND X-RAY DIAGNOSTIC DEPARTMENTS—The Personnel Officer, St. Thomas's Hospital, London, S.E.1 (April 28).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Hull (April 25).

LECTURER (with an honours degree in physics and preferably able to teach the subject to a high standard) in PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan (April 25).

SENIOR LECTURER IN PHYSICS at Fourah Bay College (University of Durham), Sierra Leone—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (April 25).

SENIOR LECTURER, LECTURER, or ASSISTANT LECTURER in (a) MATHEMATICS; (b) BOTANY; (c) AGRICULTURAL BOTANY; and (d) AGRICULTURAL CHEMISTRY, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 25).

ASSISTANT LECTURER IN BACTERIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (April 30).

ASSISTANT LECTURER (with special qualifications in organic chemistry) in CHEMISTRY—The Registrar, The University, Manchester 13 (April 30).

CHEMIST (with a degree in science, preferably with honours in inorganic and physical chemistry) in the SECTION OF SOIL CHEMISTRY, Department of Agricultural Chemistry, Waite Agricultural Research Institute, Adelaide, to conduct research into the chemical properties of soils, particularly in regard to fertility investigations—The Registrar, University of Adelaide, Adelaide, South Australia (April 30).

LECTURER, Grade II (with an honours degree in physics, and experience in the practical use of geophysical apparatus) in GEOPHYSICS—The Secretary, The University, Edgbaston, Birmingham 15 (April 30).

LECTURER or ASSISTANT LECTURER (with experience of university teaching, and preferably with special qualifications in petrology) in the DEPARTMENT OF GEOLOGY—The Secretary and Registrar, The University, Southampton (April 30).

LECTURER (with good academic qualifications and industrial experience) in ORGANIC CHEMISTRY, at Flintshire Technical College—The Director of Education, County Education Offices, Mold, Flintshire (April 30).

ASSISTANT LECTURER (with a good honours degree and special interests in stratigraphy) in GEOLOGY—The Registrar, King's College, Strand, London, W.C.2 (May 6).

LECTURER or ASSISTANT LECTURER in PHYSIOLOGY, and a SENIOR LECTURER or LECTURER in PHYSIOLOGY—The Registrar, The University, Sheffield (May 7).

LECTURER (preferable with special qualifications in micro- and semi-micro analytical techniques) in CHEMISTRY—The Secretary, The University, Aberdeen (May 7).

RESEARCH OFFICER (with a university honours degree or equivalent in physics or mechanical engineering, and preferably with research experience) in the WOVEN TEXTILE RESEARCH LABORATORY, Commonwealth Scientific and Industrial Research Organization, Geelong, Victoria, Australia, for fundamental applied research concerned with the properties of fibre assemblies—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 464/81 (May 7).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university honours degree in science with physics as a major subject, or equivalent qualification, together with some years of postgraduate experience in appropriate fields) in the NATIONAL STANDARDS LABORATORY, Division of Metrology, Commonwealth Scientific and Industrial Research Organization, Sydney, N.S.W., Australia, to undertake research in the fields of optical interferometry or microwave interferometry with particular reference to length standardization and associated quantities—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 750/115 (May 7).

LECTURER (with a good honours degree in biochemistry or organic chemistry (natural products)) in BIOCHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (May 9).

ASSISTANT LECTURER (with a good honours degree) in BOTANY, to assist in microbiology (mycology)—The Registrar, King's College, Strand, London, W.C.2 (May 10).

READER IN ORGANIC CHEMISTRY at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 12).

LECTURER (with special interests in inorganic chemistry) in CHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (May 14).

LECTURER IN MATHEMATICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 80 Gordon Square, London, W.C.1 (South Africa, May 16).

LECTURER IN METALLURGY, and a RESEARCH ASSISTANT (male or female, with experience in practical microscopy) in the DEPARTMENT OF METALLURGY—The Registrar, The University, Manchester 13 (May 31).

BIOCHEMIST, Scientific Officer grade (preferably with some mechanical aptitude), to study the composition and purification of large-scale preparations of leaf protein—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "167".

EXPERIMENTAL OFFICER (with at least higher school certificate (science) or equivalent, and experience in bacteriological research) in the VIRUS RESEARCH UNIT of a Ministry of Supply Establishment, near Salisbury, Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (J), 26 King Street, London, S.W.1, quoting G81/5A.

EXPERIMENTAL OFFICERS (preferably with a pass degree in physics), and ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. in science subjects or equivalent), to assist in investigations in a variety of allied fields including neutron generation, nuclear counting systems

and the properties of radioactive materials—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 77/WGE/34.

LECTURER OR ASSISTANT PROFESSOR to teach courses in bacteriology and in public health and some other biological subjects—W. B. Stallworthy, Mount Allison University, Sackville, N.B., Canada.

LECTURER (with a degree in biochemistry and/or chemistry, including organic chemistry taken to an advanced stage, and preferably with experience in the analysis of foods, including dairy products) in **AGRICULTURAL BIOCHEMISTRY**, at Massey Agricultural College (University of New Zealand), Palmerston North, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

PLANT BREEDER, Scientific Officer, Senior Scientific Officer or Principal Scientific Officer grade (with at least a second-class honours degree in botany, and two years postgraduate experience in cytology and genetics, preferably of tree crops) at the West African Cacao Research Institute, H.M. Overseas Civil Service, Gold Coast, to study the cytogenetics of theobroma and related genera and development of improved selections and hybrids—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.197/200/08.

PLANT PATHOLOGIST (with at least a second-class honours degree in botany and two years postgraduate experience) in the **DEPARTMENT OF AGRICULTURE**, Mauritius, to study and advise on control of diseases of economic plants, to take charge of the plant quarantine station, and to lecture in plant pathology at the Agricultural College—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/52/09.

RESEARCH CHEMISTS (with an honours B.Sc. in chemistry or A.R.I.C., and preferably with some plastics experience)—The Coal Tar Research Association, Oxford Road, Gomersal, near Leeds.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or electrical engineering or equivalent qualifications) at an R.A.F. Station near Maidenhead, Berks, for operational research duties, theoretical studies and development work in the field of communications and general electronics—Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.113/5A.

SENIOR MINERALOGIST (with a degree, with geology as a major subject, and with several years experience which has included some mineralogy) in the **MINES DEPARTMENT**, Public Service of South Australia, for the examination of ore-dressing products and the study of opaque minerals in drill cores and geological specimens involving microscopic and microchemical techniques; and a **SENIOR PETROLOGIST** (with a degree, with geology as a major subject, and some years experience in sedimentary and hard rock petrology), for the petrographic examination of sands, soils and unconsolidated sediments as well as the interpretation of rock suites and drill cores in respect of field geological investigations—The Agent-General for South Australia, South Australia House, Marble Arch, London, W.1.

SENIOR SCIENTIFIC OFFICER OR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemical engineering or in chemistry or in engineering with a chemical engineering diploma, and preferably with experience of the solution of fluid flow problems and liquid phase separations), for work on the design and development of plant for a special process involving the assessment of fundamental physico-chemical data, flowsheeting of processes and design of experimental and pilot equipments therefrom—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 550/WGE/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Observations made at the Royal Observatory, Greenwich, in the year 1945, in Astronomy, Magnetism and Meteorology, under the direction of Sir Harold Spencer Jones. Pp. viii+270+7 plates. (London: H.M. Stationery Office, 1954.) 70s. net. [271]

Ministry of Education, Science Museum. Handbook of the Collection relating to Heat and Cold. Part 2: Catalogue of Exhibits with Descriptive Notes. By J. A. Chaldecott. Pp. 64+6 plates. (London: H.M. Stationery Office, 1954.) 3s. net. [281]

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. Scottish Division. By W. Widdas. Pp. ii+26+6 plates. (London: H.M. Stationery Office, 1954.) 2s. net. [12]

Bulletin of the British Museum (Natural History). Zoology. Vol. 2, No. 11: The Southern Right Whale Dolphin, *Lissodelphis Peroni* (Lacépède). By F. C. Fraser. Pp. 339-346+plate 12. (London: British Museum (Natural History), 1955.) 5s. [12]

Institution of British Agricultural Engineers. Year Book 1954-55. Pp. 84. (Brighton: Fraser Pearce, Ltd., 1955.) [12]

National Physical Laboratory. Notes on Applied Science No. 9: Measurement of Pressure with the Mercury Barometer. Pp. iv+15+1 plate. (London: H.M. Stationery Office, 1955.) 1s. net. [12]

National Museum of Wales. Forty-seventh Annual Report, 1953-54. Pp. 63+4 plates. (Cardiff: National Museum of Wales, 1954.) [12]

University of Cambridge. School of Agriculture Memoirs. Memoir No. 26: A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organizations during the period Oct. 1st 1953—Sept. 30th 1954. Review Series No. 9: The Cambridge University Farm. Pp. 27. (Cambridge: School of Agriculture, University of Cambridge, 1955.) 2s. 6d. [12]

Building Research Station Digest No. 73: Corrosion Resistant Floors. Part 1: Design Considerations. Pp. 5. (London: H.M. Stationery Office, 1955.) 3d. net. [72]

Parliamentary and Scientific Committee. Annual Report, 1954. Pp. 24. (London: Parliamentary and Scientific Committee, 1955.) [72]

Torquay Natural History Society. Transactions and Proceedings for the year 1953-54. Vol. 11, Part 4: Birds in Our Warberry Garden during the Past Nineteen Years. By Lt.-Col. R. Kennedy. List of Officers; Proceedings; Report and Accounts. Pp. 143-172. (Torquay: Torquay Natural History Society, 1954.) [72]

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. South Western Division. By T. A. Jones. Pp. ii+21+4 plates. (London: H.M. Stationery Office, 1954.) 1s. 6d. net. [72]

Proceedings of the Royal Irish Academy. Vol. 56, Section B, No. 1: Salmon Movements Around Ireland—4. By Arthur E. J. Went and F. A. Gibson. Pp. 12. 2s. Vol. 56, Section B, No. 2: Salmon Movements Around Ireland—5. By Arthur E. J. Went and Kenneth U. Vickers. Pp. 13-28+plate 1. 2s. 6d. (Dublin: Hodges, Figgis and Co., Ltd., 1955.) [72]

Scientific Proceedings of the Royal Dublin Society. Vol. 26 (N.S.). No. 9 (June 26, 1953): Trout in Lough Rea, Co. Galway. By Ann Healy. Pp. 157-164. 2s. No. 23 (26th Sept., 1954): Perch (*Perca fluviatilis* L.) in Three Irish Lakes. By Ann Healy. Pp. 397-408. 5s. (Dublin: Royal Dublin Society, 1953 and 1954.) [72]

University of Sheffield. Report on Research Work carried out in the Department of Fuel Technology during the Session 1952-53 and the period October 1953 to April 1954. Pp. ii+27. (Sheffield: The University.) [72]

Department of Scientific and Industrial Research. Methods for the Detection of Toxic Gases in Industry. Leaflet No. 10: Chlorine. (Revised edition.) Pp. iv+6. (London: H.M. Stationery Office, 1955.) 9d. net. [72]

Other Countries

National Science Foundation. Fourth Annual Report for the fiscal year ending June 30, 1954. Pp. ix+138+4 plates. (Washington, D.C.: Government Printing Office, 1954.) 50 cents. [12]

Smithsonian Institution. Bureau of American Ethnology. Bulletin 158: River Basin Survey Papers. Inter-Agency Archaeological Salvage Program. No. 7: Archaeological Investigations in the Oahe Dam Area, South Dakota, 1950-51. By Donald J. Lehmer. Pp. xi+190+22 plates. (Washington, D.C.: Government Printing Office, 1954.) 1.50 dollars. [12]

Merentukimusalaitoksen Julkaisu. Havsforskningsinstitutets Skrift. No. 162: Observations on Currents and Winds Made on Board Finnish Light-Ships during the years 1950 and 1951. By Eugénie Lisitzin. Pp. 45. No. 163: Depth Temperature and Salinity Records Along the Coast of Finland, July 1950-June 1952. By Gunnar Granqvist. Pp. 18. No. 164: Contribution to the Knowledge of the Annual Sea Level Variations in the Northern Baltic. By Eugénie Lisitzin. Pp. 12. (Helsinki: Havsforskningsinstitutet, 1954.) [12]

Union of South Africa. Department of Commerce and Industries. Division of Fisheries. Twenty-fourth Annual Report for the period 1st January, 1952-31st March, 1953. By Dr J. M. Marchand. Pp. 200. (Pretoria: Government Printer, 1954.) [12]

Indian Forest Bulletin No. 168. (New Series)—Mycology. Studies on Indian Thelephoraceae. 1: Some Species of *Stereum*, *Peniophora* and *Coriaria*. By K. Bagchee and B. K. Bakshi. Pp. 11+2 plates. (Delhi: Manager of Publications, 1954.) 1 rupee, 8 annas; 2s. 3d. [12]

High Technical School in Belgrade. Collection of Scientific Contributions of the Electrotechnical Faculty, 1952-1953. Pp. 246. (Belgrade: High Technical School, Electrotechnical Faculty, 1953.) [22]

Technical University of Belgrade. Collection of Scientific Contributions of the Civil Engineering Faculty, 1952-1953. Pp. iv+186. (Belgrade: Technical University, Civil Engineering Faculty.) [22]

University of Technology, Beograd. Scientific Works of the Faculty of Mechanical Engineering. Pp. iii+141. (Beograd: University of Technology, 1953.) [22]

Mitteilungen der Technischen Fakultät in Skopje. (Lehrstuhl für Technische Mechanik, Baustatik und angewandte Elastizitätslehre.) Nr. 1: Beitrag zur Statik der Räumlichen Rahmen. Von Dr. Ing. Peter R. Seraimow. Pp. 72. (Skopje: Technischen Fakultät, 1951.) [22]

Institut Royal des Sciences Naturelles de Belgique. Expédition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948-1949). Résultats Scientifiques—Vol. 4, Fascicule 3A: Poissons. 4: Téléostéens Acanthoptérygiens (Première partie). Par Max Poll. Pp. 390+9 plates. (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1954.) [22]

The Coal Industry in Europe. (Trends in Economic Sectors Series.) Pp. 81. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 300 francs; 6s.; 1 dollar. [72]

Fuel Consumption of Thermal Power Stations, 1952-1958. Third Enquiry. Pp. 24. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 2s. 6d. net. [72]

Editorial and Publishing Offices of "NATURE"

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world.

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

NATURE

No. 4460

SATURDAY, APRIL 23, 1955

Vol. 175

CONTENTS

	Page
Biological Hazards of Radiation	695
David Hume : a Biography. By Prof. T. E. Jessop	697
Towards a Handbook of Crystallography. By Dr. Dorothy Hodgkin, F.R.S.	698
The Law and Merchandise Marks. By R. G. Lloyd, C.B.E.	699
James Alfred Ewing (1855-1935). By E. J. Holmgren	701
Alcohol in the Diet. By Dr. M. Weatherall	702
New Soluble Nitrogen Compounds (Amino- and Imino-Acids and Amides) in Plants. By Dr. N. Grobbelaar, John K. Pollard and Prof. F. C. Steward	703
Obituaries :	
Dr. G. M. Lees, F.R.S. By Dr. C. J. Stubblefield, F.R.S.	708
Dr. C. E. Larard	709
News and Views	709
Use of Colouring Matters in Food. By Miss M. W. Grant	714
Second International Congress of Filmology, Paris. By C. Denis Pegge	714
Commonwealth Fund, New York : Report for the Year 1953-54	715
Blood Coagulation and Thrombosis. By Dr. C. R. Ricketts	716
University of Leeds	717
Anatomy and Angiosperm Classification	717
Marine Biological Research	718
Experimental Evidence for the Collective Nature of the Characteristic Electron-Energy Losses in Solids. By Dr. D. Gabor and G. W. Jull	718
Chemical Effects of X-rays upon Aqueous Solutions of Cortisone and Deoxycorticosterone. By R. Allinson, Dr. B. Coleby and Dr. J. Weiss	720
Letters to the Editors :	
A New Antibiotic of Bacterial Origin.—Dr. A. T. Fuller	722
Quantitative Determination of Phosphatase Activity in Chick Embryo Duodenum cultured in Fluid Media with and without Hydrocortisone.—Dr. Florence Moog and Morton H. Kirsch	722
Formation and Radiosensitivity of Myoglobin.—Dr. R. Bonnichsen, Prof. G. Hevesy For.Mem.R.S., and Å. Åkeson	723
Modulating Action of the Thyroid on Oestrogen-induced Pituitary Tumours in Rats.—Prof. Joseph Gillman and Christine Gilbert	724
Effect of Potassium Ions on Brain Slices.—Yasuzo Tsukada and Genkichiro Takagaki	725
An Improved Technique for staining Blood Films with Giemsa Stain.—P. G. Shute, M.B.E.	727
Effect of Crystalloid Solutions prepared in Glass Bottles on Human Red Cells.—Dr. F. Stratton and Dr. P. H. Renton	727
The N-Terminal Amino-Acid of Rabbit Gamma-Globulin and Antibody.—Dr. Eva E. Orlans	728
Cup-plate Assay of Serum Fibrinolysin.—J. T. M. Dingle and D. P. Page Thomas	728
Colour Reagent for Paper Chromatography of Steroids.—A. Bodánszky and J. Kolonitsch	729
Detection of Iodine-containing Compounds on Paper Chromatograms.—K. Fletcher and P. G. Stanley	730
The System Niobium-Silicon and the Effect of Carbon on the Structures of Certain Silicides.—Dr. A. G. Knapton	730
Structure of the ω -Precipitate in Titanium-16 per cent Vanadium Alloy.—Miss J. M. Silcock, M. H. Davies and H. K. Hardy	731
Equilibrium of Hydrogen-Bond Formation in the Excited State.—Noboru Mataga, Yozo Kaibe and Masao Kolzumi	731
An Early Electric Valve.—Dr. D. B. McNeill	732
Relation of Radon to Non-active Air Contamination.—C. D. Thomas, M. K. Gainer and T. W. Ball	732
Control of Diurnal Rhythms of Activity in <i>Periplaneta americana</i> L.—Janet E. Harker	733
Digestion and the Production of Sulphuric Acid by Mollusca.—G. R. Fish	733
Reappearance of <i>Ocenebra erinacea</i> (L.) off the East Coast of England.—M. N. Mista'idis and D. A. Hancock	734
Control of Crabs with Crude BHC.—H. D. Jordan	734
Deoxyribonucleic Acid and Ribonucleic Acid in Hyphal Cells of Higher Fungi.—Prof. S. B. Bose	735
Effect of Sodium Chloride on Softening and Carbohydrate Charges of Date Fruits.—Dr. I. A. A. Nada and H. M. Hassan	735
A New Method for Determination of Thickness of Microtome Sections.—Olle Hallén	736

CHAPMAN & HALL

THE CHEMISTRY OF PORTLAND CEMENT

by
R. H. BOGUE

(Director, Portland Cement Assn. Fellowship, National Bureau of Standards, Washington, D.C.)

Size: 9½ in. × 6 in.

793 pages

Illustrated

132s. net

OUTLINES OF ENZYME CHEMISTRY

by
J. B. NEILANDS & PAUL K. STUMPF

(Both of the University of California)

Size: 9½ in. × 6 in.

315 pages

Illustrated

52s. net

TECHNICAL PUBLICATIONS

Their Purpose, Preparation and Production

by
C. BAKER, A.R.A.E.S.

Size: 8½ in. × 5½ in.

302 pages

Illustrated

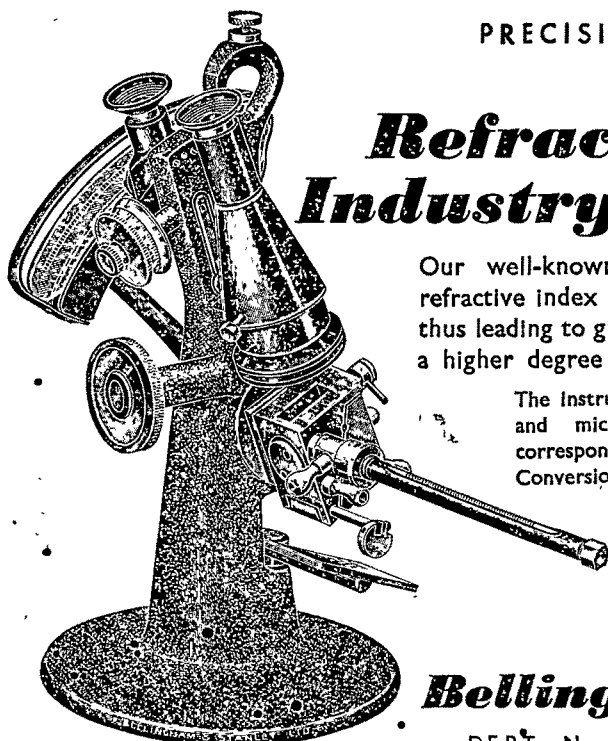
36s. net

The above new books, together with others, will be displayed on Stand 15 at the Physical Society Exhibition.

37 ESSEX STREET, LONDON, W.C.2

PRECISION  INSTRUMENTS

Refractometers for Industry and Research



Our well-known standard Abbe type refractometer has a refractive index scale on glass and is read by transmitted light, thus leading to greater convenience in taking measurements and a higher degree of accuracy.

The instrument as illustrated is supplied with degree scale arc and micrometer screw reading directly to 10 seconds, corresponding to a refractive index accuracy within 0.00005. Conversion tables for use with sodium light are supplied.

DELIVERY FROM STOCK

Full particulars sent on application.

We shall be pleased to demonstrate these instruments and give any advice within our power, if you will call at our Works.

Bellingham & Stanley Ltd.

DEPT. N, 71 HORNSEY RISE, LONDON, N.19

PHONE: ARCHWAY 2270

BIOLOGICAL HAZARDS OF RADIATION

IN the same week as the "Statement on Defence, 1955" and the White Paper "A Programme for Nuclear Power" were published in Great Britain, the Atomic Energy Commission of the United States issued a long and detailed report on the radiation and 'fall-out' produced by thermonuclear explosions. In the following week, the Federation of American Scientists communicated proposals, for an international study of the potential dangers in tests of nuclear weapons, to the Office for United Nations Political and Security Affairs of the Department of State and to Mr. H. Cabot Lodge, the United States representative at the United Nations. The text of the latter proposal for the establishment of a United Nations Commission to study and assess the potential dangers in such tests was published in *The Times* of March 24; but the proposal had become known in the meantime and was one prime cause of the stream of questions in the House of Commons on this matter during recent weeks.

A contributory factor was the admission in the White Paper that the Government had not yet been able, with the information in its possession, finally to assess the implications of the latest developments in weapons, and particularly the extensive radioactive contamination which may be caused by the 'fall-out' from a thermonuclear bomb burst at ground-level. Lack of frankness on the Government's part has led to what may well be unavoidably incomplete knowledge being construed as resulting from lack of interchange of vital information between Britain and the United States, and from failure to implement the necessary research with sufficient urgency and resources. No explanation, for example, has been given as to why the information from the Atomic Energy Commission was not made available earlier to the British Government, or, if it was, why no account was taken of that information. Even as late as March 22, written answers to questions in the House of Commons on research in radiobiology and on the effects of radioactivity upon reproductive cells seem unrealistic.

When on March 10 the Prime Minister was asked in the House of Commons to take the initiative and to propose the establishment of a United Nations Commission to study and assess the potential dangers to human beings from nuclear tests throughout the world, including long-term tests, Sir Winston replied that experts at the disposal of the Government saw no reason to dissent from the opinion of the United States Atomic Energy Commission's report, issued on February 15, that the tests so far carried out have only released enough radioactive material into the atmosphere to cause an individual living in the United States to receive the same quantity of radiation that he would have received in an X-ray chest examination at a hospital. He added that an extensive programme of research on the genetic effects of exposure to varying levels of radiation was already in progress both in Britain and in the United States of America; but that, in making its proposal

for an immediate study of the potential genetic risks of nuclear weapons, the Federation of American Scientists appeared to be envisaging dangers from a number of tests greatly in excess of those likely to be carried out in the foreseeable future.

This question of radiation effects is unfortunately being confused or intermingled with the moral or political question of the use of thermonuclear weapons, and with the practical question of the prohibition or limitation of thermonuclear test explosions. Sir Winston, for example, was asked at the same time to propose the establishment by the United Nations of an international monitoring service to detect atomic and thermonuclear explosions, and also the limitation of the number of such tests in view of the "fact" that continued tests "may" lead to long-term damage to the human race through a general worldwide contamination of the atmosphere. The Archbishop of York's important speech in the Defence Debate on March 16 followed immediately on one in which Lord Alexander of Hillsborough had testified to the general anxiety as to growing dangers to the human race from increasing thermonuclear experiments and their genetic and physical effects; but the statement by men of science of all nations of the consequences of nuclear warfare which the Archbishop advocated is obviously something more comprehensive and purely factual.

It is unfortunate that Sir Winston, like Mr. J. R. Bevens, who, in a written answer on March 7, ignored the question as to what research is being conducted on the radioactive content of the atmosphere of London, denied that there is any evidence of a significant increase in recent years or that radioactivity is a contributory factor in bronchial cancer, declined to admit that as yet we know very little about the long-term biological effects of radiation. Mr. C. R. Atlee's admission of our ignorance gives the more force to his suggestion of an authoritative statement made by scientists drawn from both sides of the Iron Curtain, and no convincing reasons were advanced in the following debate on March 14 or afterwards in the House of Lords as to why the attempt should not be made. The subject will be discussed during the forthcoming International Conference on the Peaceful Uses of Atomic Energy to be held at Geneva in August; but this Conference will be confined to scientific and technical discussions.

The situation has been clarified a little by a subsequent debate in the House of Commons, on March 22, on the genetic effects of nuclear explosions. The motion moved by Dr. Edith Summerskill wisely refrained from linking the acquisition of further information with the immediate cessation of all test explosions; while expressing fears as to long-term dangers to humanity as a result of continuing radioactive contamination of the atmosphere arising from continuing nuclear explosions, the motion merely urged the Government to give further consideration to those long-term effects and to call a conference of scientists from the United States, the

U.S.S.R., the United Kingdom and France to advise on the danger facing mankind. Meanwhile, in a written answer on the same day, Mr. J. R. Bevin had stated that the Medical Research Council's Radiobiological Unit at Harwell is carrying out a large programme of research on the effects upon the germ cell of exposure to radiation. Related studies are in progress in other establishments of the Council, and the programme aims at extending our knowledge on all the hazards which radiation may hold for human beings. The Medical Research Council has since been asked to prepare a report on the subject which is to be issued as a White Paper; and in the United States, it is announced that the National Academy of Sciences will undertake a broad appraisal of present knowledge about the effects of atomic radiation on living organisms, with financial support of the Rockefeller Foundation.

The amendment to Dr. Summerskill's motion, moved on behalf of the Government by Mr. Ian Macleod, welcomed the Government's decision "to continue and expand research in this country on the medical and biological aspects of nuclear energy, and to collaborate by every practical means with those countries with whom arrangements already exist and with such others as can usefully be brought into consultation". This decision, moreover, was set in the context of the intensive efforts which are being made to achieve a comprehensive scheme of disarmament and not in the context of a conference of scientists; and while the arguments from the Government side did not entirely dispose of the idea of a world conference on the scientific aspects of biological effects of radiation, there is clearly room for two opinions as to the value of such a conference. Even if, however, it produced nothing of scientific value, it might still be worth holding to see whether the U.S.S.R. would face or evade the issue of making known even behind the Iron Curtain the probable consequences of nuclear warfare and of the continuance of tests of thermonuclear bombs.

The Government amendment was carried at the end of a debate which was remarkably free from party politics and which was sufficiently objective to clarify some of the confusion between the political and the scientific issues. The desire for an agreed statement by scientists drawn from as wide an area as possible was manifest in all the speeches, even in those most sceptical as to the value or practicability of including Russian scientists. The Minister of Works, Mr. Nigel Birch, winding up for the Government, pointed out that the debate had been essentially concerned with the possible dangers of radioactivity caused by events short of war. To Mr. Macleod's account of the research already in progress, Mr. Birch added the further assurance that, although considerations of security did sometimes impinge to some extent, all the relevant research on biological effects of radiation is, or will be, published. He also indicated that there is excellent co-operation in this field with the United States and Canada, where knowledge and experience are even greater than ours. He thus largely met the important point made by Mrs. Barbara Castle, who referred to Prof. C. H. Waddington's plea, in *The*

Times of March 10, for more research, on a massive scale, on the long-term effects of low-intensity irradiation of mammalian populations, since this is a field demanding international co-operation and resources.

Prof. Waddington, whose plea for more research was afterwards strongly supported by Dr. H. Motz, expressed doubts whether Great Britain alone could devote to the problem resources commensurate with its importance; and he added that it is not a matter for any single country. Meanwhile, existing knowledge suggests that any increase in the level of ionization at centres of population would add its quota to the load of harmful hereditary factors which mankind has to bear. Prof. Waddington and Dr. Motz, Prof. H. W. B. Skinner and Prof. P. G. 'Espinasse and others have emphasized the limitations of our present knowledge and the inadequacy of our understanding of the probable magnitude and nature of the long-term genetic effects in man of atmospheric ionization produced by nuclear bomb tests.

In the course of his speech, Mr. Macleod gave the expenditure on such research by the Medical Research Council for 1955-56 as £208,000, and said that any recommendation by the Council, after reviewing the research programme in the light of new commitments, would be favourably considered. He added that present results have established that radiation produces genetic effects and the radioactivity of the planet has slightly increased as a result of nuclear bomb explosions. Genetic research, however, is inevitably slow, and while our present knowledge is insufficient to fix precisely the level of radioactivity above which genetic damage would significantly affect the well-being of populations, it is most unlikely that the present increase would have any appreciable genetic effect. It was a more detailed statement of this order that Mr. Elliot and others wished to see embodied in a White Paper.

The position which Mr. Macleod took up is thus roughly that of the United States Atomic Energy Commission, from the report of which he quoted in full paragraph 40, which has already caused much controversy, partly through inaccurate quotation. After this debate the Government can scarcely be accused of indifference to the manifest public anxiety; but if there is any undue delay in producing the White Paper which has now been promised from the Medical Research Council, scientists have their own responsibility for relieving anxiety as to some of the questions raised both by the Atomic Energy Commission's report and the comments on that report by the Federation of Atomic Scientists. Such action indeed is imperative if public opinion is not to be confused, or policies and action urged on the Government which are conducive to neither national security nor national welfare.

From the medical side, one such attempt has already been made in the *British Medical Journal* which in a leading article on March 26 put concisely and clearly the limitations of our existing knowledge, the factors of which the United States Atomic Energy Commission report appears to take insufficient account, and the directions in which further know-

ledge is urgently needed. Although that report indicated the real magnitude of the radiation hazards associated with the testing of nuclear weapons, it dealt chiefly with the damage caused by the 'fall-out' or deposition of radioactivity in the vicinity of the explosion. For the Bikini test this amounted to some 20 million röntgen square miles, covering an area of 7,000 square miles, serious danger being limited to a belt 140 miles long and 20 miles wide; but on the important problem of radioactivity other than in this fall-out, the report says nothing. For thermonuclear bombs of the type now available, the fall-out could well be five times as great; and although much of the radioactive mist reaches very great heights, we know very little about the movement of the atmosphere at such heights. Moreover, even if the radioactive dust takes as much as six months to settle instead of six days, the residual radioactive dose may be reduced only by one half. There is also the important question of how long such radioactive dust remains on the surface before it is washed away.

Answers to such questions as these are not to be obtained readily, and though the evidence is as yet insufficient for definite conclusions, as the Federation of Atomic Scientists admits, it is possible, if not probable, that continuation of nuclear bomb tests on the present scale would double the natural amount of atmospheric radiation. Even this may well be too low to cause much genetic damage; but it cannot be said that continuance on the present scale over many years will not constitute a serious genetic hazard, and for that reason alone the Federation of American Scientists stresses the urgent need for intensive study of the problem of radioactive contamination resulting from bomb tests. Major responsibilities of the United Nations Commission which it is proposed should be established would be to obtain scientific data and expert opinion on the magnitude of the radiation intensities involved; to obtain and evaluate scientific opinion on the biological and genetic effects of radiation on human beings and to establish an agreed danger threshold. The results of this study would be reported to the General Assembly of the United Nations, with recommendations as to the procedures required to avoid exceeding the danger threshold.

This proposal thus appears to be eminently practical and to be free from the political complications which would attend unilateral decision, on present evidence, by the United Kingdom or the United States, to discontinue nuclear test explosions. They have been endorsed essentially by Prof. J. Rotblat in an article in the March issue of the *Atomic Scientists' Journal*, in which he specifically urges publication by the Government of all known data about the genetic effects of radiation resulting from the nuclear bomb tests. The important point is that existing information should be made known as widely and fully as possible, with a clear explanation to the non-scientist as to its exact implications. Unless this is done urgently and efficiently, it is clear that public opinion could easily be confused and stampeded into measures inconsistent with either health or security.

In that task of interpretation and exposition the scientist has an important part to play. On him, too,

lies largely the responsibility for constructive criticism of any measures which the Government may propose, not least in respect of the adequacy of the resources allocated to research in this field, and of the extent of international co-operation in such research and the promptness and efficiency with which results are exchanged. To the scientist also the nation must look for guidance as to the completeness with which the field is being covered and the directions in which further research is most urgently required. The adequacy and the disposition of the resources made available for research will be influenced very considerably by the vigilance and public spirit of scientists in general, and to them the public must look, not only for the assurance that the gaps in our existing knowledge will be filled as completely and swiftly as is possible, but also for guidance as to the measures required to safeguard mankind from the real hazards with which we are at present confronted.

DAVID HUME: A BIOGRAPHY

The Life of David Hume

By Prof. Ernest Campbell Mossner. Pp. xx+683+20 plates. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1954.) 42s. net.

HUME's importance warrants a biography, his travels and varied activities provide the stuff of one, and surviving records are ample enough to make one possible. Over the dull lives of many philosophers time has drawn a sponge; but Hume was more than a philosopher, inserted himself into diverse circles, was a 'character', had many big friends and more petty enemies, and consequently was widely mentioned. One indication of his prominence is that a large number (apparently a large proportion) of his letters have been preserved. The ample material was worked up into a lengthy biography in 1846 by John Hill Burton, and digested afresh in a shorter "Life" by J. Y. T. Greig (1931). The least that this book by Prof. E. C. Mossner proves is that the extant material is even ampler and more widely scattered than we had known: with immense skill and industry he has brought new things out of old sources and tracked down new sources, checking what his predecessors have written and adding to it considerably. Further, holding a chair of literature (in the University of Texas), he knows how to present his material. The total result is a rich, illuminating and absorbing volume, which must be immediately acknowledged as the standard biography of Hume.

Hume lived before the higher learning was broken into bits. This is one reason why it is good for us to read him. He studied at least the elements of mathematics and physics at Edinburgh, the first university outside Cambridge to teach Newton's "Principia". He had a close acquaintance with the Greek and Latin authors (not only those that are known as classical), was nearly as much at home in French as in English literature, and read some of the Italian writers. He composed a much-read "History of Great Britain" (in six quarto volumes) that set a new standard of both objectivity and width of human interest, and wrote some pioneering and penetrating essays in economics and some admirable ones on political science; and in these as in his philosophical

works he wrote a straightforward yet elegant prose that is an admonition to us specialists who have made the language of education barbarous.

As a philosopher, Hume should be congenial to scientists, for he expresses emphatically the critical and cautious spirit of science. It is not an accident that one of the good books on him was by T. H. Huxley (in the "English Men of Letters" series). Hume was an admirer of Newton's achievement in pulling together a vast field of phenomena by means of the principle of gravitation not postulated as an occult force but proved as an empirically verifiable uniformity; and it was this brilliant success of scientific method that prompted him to search for a comparable law in the sphere of mind. This means that his primary aim was to establish psychology as a systematized natural science; and the comprehensive law which he propounded and believed he had verified, the law of association, remained the Ariadne-thread of British psychology until after the middle of the nineteenth century. In his psychologizing, however, he kept turning aside to philosophical problems, and either tore them to pieces or pronounced them to be insoluble. His general principles here were: (a) that reason can do no more than discern the logical relations of ideas, from which no inferences about existence can be demonstrably drawn; (b) that existence is known to us only in subjective data, the regularities of which can be noted but not explained; and consequently (c) that belief in anything behind the data of the senses, though the belief is inexpugnable and sane, is incapable of being proved. This anti-metaphysical contention makes Hume one of the heroes of the contemporary British positivists, and should appeal to those students of science who would like to find philosophical reasons for not giving a realistic meaning to the entities and relations of theoretical physics.

The literature on Hume's thought being considerable, Prof. Mossner has addressed himself to the events and *milieu* of Hume's life, which have not been written about much and which, he shows abundantly, called for a fresh investigation. He has recovered them with a remarkable wealth of detail, authenticated by precise references to contemporary or nearly contemporary sources; and he has allowed the interest to arise from the detail and its concatenation, instead of plastering it on with clever phrasing and pseudo-profundity of comment. He presents Hume, not himself. He recreates the intellectual life of Edinburgh, Hume's real home between his various moves, and the exquisitely civilized gatherings in the *salons* of Paris, where, not as an official of the British Embassy but as a proved thinker and writer, Hume was received with extraordinary honour. It is interesting to read for the first time a circumstantial account of the military expedition to Brittany in which Hume took part, and the new things that are told of his diplomatic work in Paris and of his spell in London as Under-Secretary of State. Good sayings and good stories punctuate the long narrative. Hume emerges through it all as a man of sense, humour, honour and benevolence. The source of his intellectual precocity remains hidden: presumably it was in himself, not in his environment. As in other good biographies, we are taught a period of history concretely and humanely, and therefore probably more truly than in the general sweep of the history books with which most of us are familiar.

The publishers have given this important piece of research a worthy dress: binding, printing and illustrations are all of a quiet excellence, and it is a delight to see again margins of the pre-war width. The volume will have to be put as a matter of course in every university and large public library; every Scot should have it in his own; and every lover of scrupulous yet lively biography may well expose himself to the temptation of it. T. E. JESSOP

TOWARDS A HANDBOOK OF CRYSTALLOGRAPHY

Crystal Data

Classification of Substances by Space Groups and Their Identification from Cell Dimensions. By J. D. H. Donnay and Werner Nowacki, with the collaboration of Gabrielle Donnay. (Geological Society of America Memoir No. 60.) Pp. ix + 719. (New York: Geological Society of America, 1954.) n.p.

I FIND it amusing to open this book almost at any page and to consider what accidents of crystal chemistry and recent history have brought together, side by side: haemoglobin and lead monoxide hydrate, for example, or hydrogen iodide, xenon and barium fluoride, or β -sitosterol H_2O (from rubber) and 4:5-antimony sulphide-lead sulphide. For this book is a compendium of all the variety of X-ray measurements on single crystals which have been collected in the past thirty odd years, nicely mixed together through the operations of classification by crystal symmetry and crystal axial ratios.

The book is a practical demonstration of the extent of the problem as it now exists of making a collection of crystal data. It includes measurements on nearly six thousand crystals studied for a variety of chemical and crystallographic purposes. The mere process of grouping them together as Prof. W. Nowacki does in Part 1 of the book, by space groups, underlines the arbitrary character of the existing material. This does not mean that the formal conclusions that might be drawn from Nowacki's lists are necessarily wrong. The commonest four space groups found among organic compounds, for example, are $P2_1$ (127), $P2_12_12_1$ (144), $P2_1/c$ (355) and $Pnma$ (192), of which the first two are particularly appropriate for the packing of asymmetrical molecules. Prof. Nowacki fears that crystallographers avoid triclinic crystals, and hence these appear less commonly in measured examples than they do in Nature. Actually, from my own experience, I should say that triclinic crystals really are considerably less common than monoclinic and orthorhombic; and $P2_1/c$ particularly is so dominant among space groups that a suspicious character like myself, looking at a list of examples of compounds said to belong to $P2/m$, immediately wonders if some have been wrongly measured—one at least, creatinine, really has got the space group $P2_1/c$ according to later observations (private communication from H. Mendel). Among inorganic compounds, on the other hand, the most common groups, face-centred cubic and close-packed hexagonal, probably do reflect the accumulation of data on simple substances up to the present. Extensions to come will certainly add considerably to the numbers here in lower-symmetry space groups.

The largest part of this book, Part 2, is the list, compiled by Prof. J. D. H. Donnay with Dr. Gabrielle Donnay, of crystals under the main

divisions of the different crystal systems. Within each system, the compounds are listed in order of axial ratio; for each the name, formula, unit-cell dimensions, structure type, specific gravity, and at least one reference are recorded. The list is extremely useful for reference—to find quickly whether a particular crystalline species has been examined at all and how much is known about it. It can also easily be used for identification whenever (still a rather serious limitation) the compound investigated is included in it. But for this particular end, it might be better in future to adopt a different form of listing, for example, in order of length of unit-cell dimensions. One might then hope occasionally to effect identifications with fewer precise measurements—and the actual size of a unit cell is itself often a considerable clue to the nature of the compound present. (Incidentally, thymonucleic acid could not be cubic, $a = 3.35$, as in this list, even if Astbury and Bell said so—which they did not.) One cannot, of course, really confuse haemoglobin, with cell dimensions 76.6, 56 and 49 Å., with lead monoxide hydrate, 6.36, 4.65 and 5.93 Å., although $a:b$ is 1.367 and 1.368, respectively. But one cannot help feeling that a classification would be more natural which placed them farther apart.

Clearly the authors have done a great service to all those who need to use crystal data for widely varying practical purposes, by collecting together so much material in so comparatively brief and coherent a fashion. The labour of sorting so much information from the literature and then recalculating and reassigning lattice dimensions and axial ratios must have been enormous. But if the authors do turn now—as one hopes they will—to making a real handbook of crystallography, they should surely build it up on different principles. No single classification can bring out all the relations one would like to see made clear. But certainly some serious rethinking of crystal chemical forms of classification is now most urgent and desirable.

DOROTHY HODGKIN

THE LAW AND MERCHANDISE MARKS

The Law of Merchandise Marks, including the Merchandise Marks Act, 1953

By The Hon. H. Fletcher Moulton and P. G. Langdon-Davies. (Reprinted from Butterworths Annotated Legislation Service.) Pp. 170. (London: Butterworth and Co. (Publishers), Ltd., 1954.) 17s. 6d. net.

THE authors of this small but concisely written book, the Hon. H. Fletcher Moulton and Mr. P. G. Langdon-Davies, are to be congratulated upon producing within a small compass such an admirable and useful summary of the Merchandise Marks Acts. Many judges have deprecated the obscurity and complexity of the language in these Acts concerning, as they do, so closely the welfare of members of the public and having to be administered by lay justices. But the authors have by careful paragraphing with many sub-headings, and a good index, produced a book which is bound to be of great value to business men, as well as lawyers.

As the authors point out, there has always been a reluctance on the part of governments to pass legislation affecting trade. 'Caveat emptor' has persisted

as the motto of the jurist, and 'laissez-faire' has largely controlled the methods of the legislator in regard to the trade in the mass of goods which are the subject of advertising slogans. The protection of the consumer does not seem to be an issue over which members of the public or political parties themselves show much enthusiasm. Yet various ways of bamboozling the consumer are rampant and widespread at the present time.

The Merchandise Marks Act 1953, which came into operation in January 1954, has widened somewhat the scope of the Merchandise Marks Act of 1887, which is the principal Act on which all subsequent ones have been grafted. It does little, however, to remove the uncertainties and obscurities of the earlier Acts, which are most difficult to construe. This is particularly unfortunate when so much of the initial work relating to prosecutions under these Acts is dealt with before lay justices. However, the 1953 Act does extend the definition of the terms 'trade description' and 'false trade description'. 'Trade description' now covers statements as to the quality of goods according to a standard used or recognized in the trade or as to the fitness for purpose, strength performance or behaviour of the goods in question. The term 'false trade description' has been amended so as to include a trade description which is misleading in a material respect as regards the goods to which it is applied. These extensions will probably have far-reaching effects.

A short while ago one of the first prosecutions under the new Merchandise Marks Act relating to a trade description which was misleading received considerable publicity at Bournemouth, when a shopkeeper was fined £50 for selling sheets described as "top quality flannelette" when they were nothing of the kind. The addition of the new class of description that has been included by the 1953 Merchandise Marks Act, namely, "as to the fitness for purpose strength performance or behaviour of any goods" (Section 1 (ab)), is probably from the practical point of view the most important change made by that Act. There are a number of words and phrases which have been particularly common in modern commerce and the use of which hitherto it has not been possible to stop. Such words or phrases claiming that goods are 'unbreakable', 'unshrinkable', 'mothproof', 'rustless', 'waterproof', 'doesn't damage delicate fabrics', to name a few, now become trade descriptions within the meaning of the Act. If they are misleading in a material respect as regards the goods to which they are applied, then the persons or firms manufacturing or marketing the goods can be prosecuted under the Merchandise Marks Act.

These prosecutions can be undertaken by government departments such as the Board of Trade and the Ministry of Agriculture in certain cases, by local authorities in cases which affect the inhabitants of their area, and by the laying of information at petty sessional divisions in accordance with the procedure applicable to magistrates' courts. The vast majority of prosecutions have been dealt with summarily in magistrates' courts.

The details of the procedures to be adopted, the nature of the issues likely to arise, and summaries of leading cases decided by the courts are all clearly set out in this book. It is to be hoped that it will make a valuable contribution in assisting those persons who are willing to help in clearing away the misleading advertisements and practices arising in trade.

R. G. LLOYD

Journal of the Institute of Metals

Volume 81, 1952-53. Edited by N. B. Vaughan. Pp. xvi+768+106 plates. (London: Institute of Metals, 1953.) 60s.

THE Institute of Metals is concerned with theoretical structural metallurgy and the metallurgy of the non-ferrous metals, excluding extractive considerations, and the present volume of its *Journal* contains a representative selection of papers (and discussion). Numerous papers deal with alloy constitution, deformation and behaviour under stress, but also covered are subjects such as viscosity and surface tension, grain refinement of cast metal, metallographic techniques, solid transformations, corrosion and oxidation of metals. In addition, a symposium is included on the control of quality in the melting and casting of ingots for working.

The majority of the papers describe the results of first-class experimental work. They are well written in a concise manner. They are carefully sub-titled, so that coupled with the provision of good synopses, it is easy for the reader to find quickly the information desired.

The format of the *Journal* is of the highest standard. The photographic reproductions are of fine quality, although it is a pity that, in the interests of economy, they are grouped together in what constitutes each monthly issue. The line-drawings are well made and carefully standardized. In all, the *Journal* represents a praiseworthy achievement. A. R. BAILEY

Radioisotope Conference 1954

Sponsored by the Atomic Energy Research Establishment, Harwell. Proceedings of the Second Conference, Oxford, 19-23 July. Edited by J. E. Johnston, with the assistance of R. A. Faires and R. J. Millett. Vol. 1: Medical and Physiological Applications. Pp. xi+418. 65s. Vol. 2: Physical Sciences and Industrial Applications. Pp. ix+223. 45s. Set of two volumes 100s. (London: Butterworths Scientific Publications, 1954.)

THE editors and publishers are to be congratulated on producing this report of the second Oxford Radioisotope Conference within a comparatively short time after the meetings. The magnitude of this task is indicated by the fact that some seventy papers on a very wide variety of subjects are reproduced in full, together with verbatim accounts of the discussions following each paper. Perhaps the most striking feature of these two volumes is the distribution of the subject-matter over the various scientific fields. Of the seventy papers, forty-six are concerned with medical and physiological applications of radioactive isotopes, while the remaining twenty-four are spread over various branches of chemistry, physics, metallurgy and industry. If these figures give a true picture of the distribution of uses of isotopes, there is an implication of a regrettable slowness in making use of these new scientific tools over a wide range of applied science.

As pointed out by Sir John Cockcroft in his opening speech, this was not a specialist conference but rather one designed to dispassionately spread the knowledge of radioisotopes as tools of research. This outlook is demonstrated in the published papers, where the emphasis throughout is on techniques and where experimental results are used largely to illustrate advances in technique. An attempt has been made to divide the papers under subject headings, and from the point of view of the main purpose of the

Conference, this may not be considered entirely satisfactory. It results, for example, in related techniques being found in widely separated parts of the books. This is, however, a minor defect and does not detract from the value of this report as a most important addition to the literature on radioisotopes. In such a rapidly expanding field, it seems certain that further conferences and reports will be needed.

J. E. R.

The Birds of Ireland

An Account of the Distribution, Migrations and Habits as Observed in Ireland. By P. G. Kennedy, S.J., Robert F. Rutledge and C. F. Scroope, assisted by G. R. Humphreys. Pp. xv+437+11 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 42s. net.

ALTHOUGH books on birds in general are legion, those on the ornithology of Ireland are by no means numerous; indeed, no comprehensive work has been published since that of Ussher and Warren in 1900. During this time many changes have taken place in the status of a variety of species. Some have been lost and some gained. In the present volume P. G. Kennedy, R. F. Rutledge, C. F. Scroope and G. R. Humphreys have endeavoured to supply this want and deal with the "Birds of Ireland" as they are to-day.

Taking them species by species, they describe the position of each, often having much to say concerning fluctuation of numbers and alteration of status. For example, of the red-necked phalarope they write: "In 1900 two or three pairs were noticed during the breeding season in a marsh in Co. Mayo, and two summers later breeding was definitely established. Since 1902 a colony has bred there with varying success. It seems to have reached its greatest strength in 1905, when about fifty pairs were found. . . . In 1932 Mr. P. E. Dunn and the writer could count only twenty-five birds". They go on to recount the gradual decline of this and neighbouring colonies, pointing out that some of the blame must go to the collectors who took heavy toll of the eggs; but the destruction of nests and eggs by cattle must not be overlooked. Their summing-up of the present position of this phalarope in Ireland is "summer visitor in small numbers and very local. Has decreased rapidly. Extremely rare as an autumn migrant". FRANCES PITT

Reports on the Progress of Applied Chemistry Vol. 37, 1952; pp. 983. Vol. 38, 1953; pp. 989. (London: Society of Chemical Industry, 1954.) 60s. each vol. (40s. to members).

THE excellent survey of applied chemistry provided by these annual reports is familiar to chemists, and no general description of their contents should be necessary. It may, however, be useful to mention that they are likely to be serviceable in a wider field. In the present volumes, for example there are sections on agriculture and horticulture dealing with pest control, which should interest botanists; there are also sections on medicinal substances and antibiotics, which will be useful to those interested in medicine.

The general fields of applied chemistry are admirably covered. In view of the very wide range of literature used by the reporters, the volumes, which have author and subject indexes, give a comprehensive survey of all branches of applied chemistry and are indispensable in any chemical library.

JAMES ALFRED EWING (1855-1935)

By E. J. HOLMGREN

Engineering Laboratory, Cambridge

IN an age where extreme specialization in engineering is the rule rather than the exception, it is not always easy to realize that it was usual for engineers to be what might be broadly termed 'general engineers', that is, being equipped with a mixture of the major branches of engineering that was expected to serve them through their professional career. Many of the great engineers of the nineteenth century were such men, and perhaps the last of these was Sir Alfred Ewing, the centenary of whose birth occurred last month. But in Ewing's instance, his training served him for more than merely his professional career; it served him in his scientific researches and in his capacity as a teacher, for perhaps few men have had such a far-reaching effect on British engineering education.

James Alfred Ewing was born in Dundee on March 27, 1855, and received his early education at two of the schools of that city—the West End Academy and the High School. Following this, he won a scholarship of the value of £40 per annum which enabled him to enter the University of Edinburgh, where he studied engineering under Fleeming Jenkin—a man who later exercised a great influence on his life. Jenkin was at the time engaged on research on submarine cables, under the direction of Lord Kelvin, and on his recommendation Ewing spent his summer vacations at Greenwich working on problems in this field. During 1874-76 he made three voyages to South America in connexion with this work, and on his return to Edinburgh completed his B.Sc. degree in engineering.

At the suggestion of Jenkin, Ewing accepted, in 1878, the offer to go to Tokyo as professor of mechanical engineering in the newly established university there. For the five years that he was in Tokyo he organized the chair and carried out researches on the measurements of earthquake movements, designing instruments for this. 1883 found him back in Britain, this time at Dundee, where he was professor of engineering at the then recently founded University College.

Ewing remained at Dundee until 1890, in which year he was appointed professor of mechanical sciences at Cambridge—an appointment which, unknown to him, was to have far-reaching results. At this time, however, the course in mechanism, as it was then known, had fallen into some disfavour, and the Senate would have been glad to drop the whole matter; but this was not possible. Under Ewing, the chair was completely reorganized, the course of instruction laid down, the Tripos established in 1892, and considerable extensions made to the laboratory buildings. While at Cambridge, Ewing carried out researches on the structure of metals, hysteresis, and designed instruments such as a permeability bridge and extensometer.

In 1903 Ewing was appointed director of naval education in Britain, and in this capacity he superintended the complete reorganization on engineering lines of the training of officers. In 1914, with the outbreak of the First World War, this came to an end, and Ewing was then in charge of "Room 40"—a department of the Admiralty entrusted with the decoding of enemy cyphers.

The association with the Admiralty came to an end in 1917, when Ewing was appointed vice-chancellor and principal of the University of Edinburgh. During his tenure of office there, thirteen new chairs were established, new buildings erected and the whole institution organized on modern lines. This vice-chancellorship may be said to be the climax of Ewing's active career. In 1929 he retired to Cambridge, where he spent his remaining years taking an active part in research bodies and learned societies and writing. He died on January 7, 1935.

In assessing the work of Ewing, it is seen that his greatest accomplishments lay in the founding of three engineering schools. It was his pioneer spirit that took him to Tokyo and it was his foresight and administrative ability that laid the foundation for the chair of mechanical sciences at Cambridge, for had a lesser man than he been appointed the development of engineering at Cambridge might have been delayed by many years, and certainly not have reached its present stature; however, it is not wise to speculate in such instances. It is to his everlasting credit that engineering at Cambridge has attained the high standard that it now holds. It was the experience gained from Tokyo; Dundee and Cambridge that stood him in good stead as vice-chancellor of the University of Edinburgh and enabled him to guide it to the eminent place that it holds among British universities.

The task with the Navy had educational features common with his work at the universities, in that the course of training was organized on engineering lines. This change might have been viewed with scepticism by some at the time; but at the Admiralty, men such as Lord Fisher realized the need for such a course, which was to serve the Navy well in two world wars.

The final years of Ewing's life might be said to be a period of retrospect, in which, in his addresses to learned societies, he looked back over the past progress of science, its developments, and its future implications for mankind. Delivering for the second time the James Forrest Lecture in 1928, Ewing voiced the thought that, although engineers had brought great benefits to humanity, they had at the same time created a great potential for ruin. To the British Association he posed the question, was science, explaining to the layman that broad outlook it possessed in spite of specialization. He sounded a warning here that perhaps the effect of great discoveries was not altogether beneficial, since man was not altogether prepared for the bounty that Nature had bestowed upon him, for, although he commanded Nature, he did not seem to be able to command himself—a warning which has its significance to-day.

Ewing was the recipient of many honours, among them the Royal Medal of the Royal Society, awarded to him in 1895 for his researches in magnetism. In 1907 he was made a C.B., in 1911 a K.C.B. He was awarded honorary degrees by the Universities of Cambridge, Oxford, Durham and St. Andrews, and held executive positions in many learned societies.

Ewing was the author of many papers on scientific subjects as well as several books, such as "The Steam Engine and Other Heat Engines", now regarded as

a classic, "Strength of Materials", "The Mechanical Production of Cold", and "Thermodynamics for Engineers", the last of which he was writing at the time of his death and which is still read to-day.

Ewing is remembered by those who knew him as a fine lecturer and a teacher who took a great interest in the work of students whom he taught, and as a scientist, in the work of those with whom he worked. To the end of his life he continued to maintain his interest in engineering research and education, and it is perhaps significant that his most fitting memorial is the James Alfred Ewing Medal, awarded by the Institution of Civil Engineers for noteworthy contributions to engineering science. Established in 1936 and first awarded in 1938, it remains to-day as a living monument to one who was scientist, engineer and educator.

ALCOHOL IN THE DIET

VARIOUS aspects of the advantages and disadvantages of alcohol as a dietary constituent were discussed at a symposium of the Nutrition Society on "Alcohol and its Nutritional Significance", held on March 12 in the Wright-Fleming Institute of St. Mary's Hospital Medical School, London, under the chairmanship of Dr. H. E. Magee.

The extent to which alcohol is consumed varies widely, and Prof. E. M. Jellinek showed how misleading gross *per capita* figures can be unless they are broken down into their component details. For example, children make a negligible contribution to the alcohol consumption of a population, and must be allowed for accordingly. A theoretical maximum individual intake of alcohol can be postulated above which it cannot be metabolized and would therefore accumulate; on the commonly accepted figure of 100 mgm./kgm. body-weight per hour, this limit would be about 170 gm. per day. However, there is considerable variation in the rate at which different individuals metabolize alcohol. The frequency distribution of the rates is rather more flat-topped than a normal curve, and rates between 60 and 150 mgm./kgm./hr. are all common. With a high rate of metabolism in a heavy man, a total consumption of up to 400 gm. per day is not to be ruled out as impossible. After excluding children and perhaps impossible figures, it is necessary also to allow for abstainers and for alcoholics. Information from different sources about the incidence of abstainers in the United States are in good agreement, and the number of alcoholics is well known. For the rest of the population, it appears that men drink about three times as much as women, and on this basis the average alcohol consumption of adult Americans who are not abstainers or alcoholics can be estimated at about 46 gm./day for males and 15 gm./day for females. For the alcoholics, of whom there are about a million in the United States, the daily consumption is about 225 gm./day, so that these 8 per cent of all consumers account for about one-third of all the consumption of alcohol in the United States. The details differ, but similar pictures can be presented for other nations. It follows that, in general, alcohol makes a negligible contribution to a national calorie budget but that, when the figures are broken down, the contribution is appreciable at some levels as well as being serious as an interfering factor in overall nutrition at high levels.

The utilization of ingested alcohol was discussed by Dr. J. Tremolieres, who reported particularly the work of Dr. E. Le Breton and Dr. L. Dontcheff. By administration of alcohol to rats and then killing the rats and estimating the amount of unoxidized alcohol in the tissues, it is possible to measure the rate of consumption: in rats this rate is surprisingly constant, and agrees well with determinations based on the rate of decline of the concentration of alcohol in the plasma. The rate of metabolism of alcohol does not depend on the dose of alcohol, and the rate is also unaffected in homoiothermic animals by altering the environmental temperature or by muscular activity. On the other hand, in starvation the rate of utilization is decreased, and the rate can be increased by administering insulin. From experiments with alcohol labelled with isotopic carbon, it appears that metabolic products of alcohol are utilized in the synthesis of fat.

Among the consequences of ingesting alcohol are a sense of well-being, impaired self-criticism and impaired performance of many kinds of skilled action. The other pharmacological actions of moderate doses of alcohol, such as vasodilatation, diuresis and impaired sexual efficiency, are of less practical importance, and Dr. M. Weatherall concentrated on the immediate consequences of including alcohol in the diet, apart from its possible nutritional value. Loss of skill is important when complicated and potentially dangerous actions are performed under the influence of alcohol, and it is useful to assess how much alcohol can be consumed before detectable loss of efficiency occurs. One of the skilled actions most commonly performed under the influence of alcohol is driving motor vehicles, and evidence is available showing that alcohol contributes substantially to the incidence of road accidents. Laboratory studies do not localize the effects of alcohol to any particular part or function of the nervous system but they permit estimation of threshold quantities for the impairment of various functions; and such studies generally indicate that loss of efficiency begins at about 0.04–0.06 per cent of alcohol in the blood. From such figures it follows that it is unwise to drive a car shortly after consuming more than a pint of beer on an empty stomach. Apart from impairment of skilled actions, there do not appear to be other objections to the consumption of small amounts of alcohol, and there is good evidence that in the long run moderate consumption of alcohol is associated with a greater expectation of life than that enjoyed by total abstainers.

The afternoon session was more directly concerned with nutritional aspects of the use of alcohol. Dr. H. M. Sinclair examined two questions: Does vitamin deficiency predispose to alcoholism? And does alcoholism predispose to vitamin deficiency? Evidence on the first point is unconvincing. Whether rats have a choice between drinking water and drinking dilute alcohol, they usually choose water: their diet is adequate in calories and alcohol if it is inadequate. On diets deficient in vitamin B₁, the commonly choose alcohol; but on such a diet their calorie intake is usually also inadequate because their appetite is poor, and so their choice of alcohol is not significant. Moreover, in alcoholic humans extensive dietary supplementation with vitamins usually has no effect on the intake of alcohol. On the other hand, vitamin deficiencies are well known as a sequel to alcohol consumption. Alcohol has an acute effect on vitamin A mobilization from the liver.

and it impairs dark adaptation. Chronically, effects depend partly on the form in which alcohol is taken: spirits generally yield very little other nutritive matter, whereas a pint of beer provides a substantial fraction of the daily requirement of niacin and appreciable amounts of other vitamins. The typical disorders resulting from excessive consumption of alcohol are fatty infiltration and cirrhosis of the liver, depending on an increased requirement for choline; Wernicke's encephalopathy, due to lack of thiamine and reversible by treatment with it; and peripheral neuropathy perhaps due to the same cause. On the other hand, Korsakow's psychosis appears not to be due to a deficiency of vitamins.

Prof. B. S. Platt was prevented by illness from giving his communication in person; but it was ably presented on his behalf by Dr. C. R. C. Heard. Among indigenous African communities, five kinds of alcoholic beverage are commonly used. They are obtained by the fermentation of honey water, fruit juices, palm sap, milk and grain respectively: fermented palm juice and beer appear to be the most common. These drinks usually contain not more than 5 per cent of alcohol and often less, and they are valuable for their accessory nutritional values, such as nicotinic acid and riboflavin. They are also sometimes preferable to water for human consumption because they avoid the risks of water-borne infections. They are important socially because the ability to provide such drinks is regarded in the community as evidence of social status, and members of a community who fail to offer alcoholic hospitality become outcast. These drinks are valuable also as an interruption of the monotony of life, and they are used in the promotion of co-operative labour in the shape of beer working parties which perform various kinds of agricultural labour that are more effectively carried out communally. The nutritional consequences of the use of these beers therefore include the improvement in feeding which results from the extra food grown by means of such working parties. It is sometimes felt that considerable losses of nourishment occur when grain is converted into beer, but in fact the change in calorie value is very small, and substantial increments in accessory factors are obtained as a result of microbiological activity. On the whole, the use of these native drinks is to be encouraged rather than regretted; but this does not apply to some of the more sophisticated drinks which have been obtained, for example, by the fermentation of golden syrup and subsequent distillation of the products, or from purchased imported gin.

The use of alcohol administered intravenously as a food in patients who are unable to take nourishment by mouth was discussed by Mr. A. W. Wilkinson. For such patients, probably requiring 2,100 calories a day, or more if much tissue catabolism is occurring, unsupplemented intravenous glucose has to be given in enormous volumes or undesirable concentrations in order to provide for their needs. Unsupplemented protein hydrolysates are valuable, but inefficiently utilized unless sufficient carbohydrate is given with them. Solutions of 6 per cent alcohol can be administered without worse effects than making patients drowsy, and can provide up to a thousand or more calories daily. Better results can be obtained by combining alcohol with a sugar and with amino-acids. Fructose is preferable to glucose because it accelerates the oxidation of alcohol, and a solution of 10 per cent fructose, 5 per cent amino-acids and 3 per cent alcohol provides 911 calories per litre. Up

to fifty or sixty litres of such solutions have been given to patients over periods of weeks, and they are therefore reasonably safe provided that they are not used when intracranial pressure is raised or in patients with head injuries.

Discussion both in the morning and afternoon was concerned particularly with the metabolic fate of alcohol, and it was generally agreed that the limiting factor in the rate of utilization of alcohol is the rate at which it is oxidized to acetaldehyde, a process probably occurring mainly in the liver. The next stage, oxidation to acetate, provides material which can be used for many physiological syntheses, but the fate of the acetate probably depends on the site at which it is formed. This aspect of alcohol metabolism requires further study, preferably with molecules isotopically labelled at as many points as possible. The inhibition by disulphiram of the oxidation of acetaldehyde to acetate was mentioned, and it was suggested that some of the chronic toxic effects associated with alcoholism may be due to the acetaldehyde formed from it. Tolerance to alcohol depends largely on the rate at which alcohol dehydrogenase operates, and there are substantial individual differences in the activity of this enzyme, possibly partly innate and partly acquired. Much interest was shown also in the nutritive value of other ingredients of alcoholic liquids, and on this score at least it appeared to be generally agreed at the symposium that beer is best.

M. WEATHERALL

NEW SOLUBLE NITROGEN COMPOUNDS (AMINO- AND IMINO-ACIDS AND AMIDES) IN PLANTS

By DR. N. GROBEELAAR, JOHN K. POLLARD
and PROF. F. C. STEWARD

Department of Botany, Cornell University, Ithaca,
New York

THE familiar but salient dates in the history of the simpler nitrogen compounds to be found in plants tell the story of knowledge slowly, but inevitably, unfolding. From the recognition of the amino-acid character of cystine in 1810, the early recognition of asparagine as a widespread constituent of plants (1806), not chemically identified until 1862, the discovery of glutamine in 1883, through the classical investigations of Schulze (1877-1910) and his pupil Prianischnikow (1895-1910) the march of progress is sure and sedate. Within the present century it came to be tacitly admitted that any of, or all, the amino-acids of protein hydrolysates could occur in the free state in plants, though their recognition and isolation might well presuppose the use of plants or organs in which some particular substance is present in unusual or predominating amounts. In the frequently cited paper of 1906, Schulze recognized the free occurrence of the following ten amino-acids in plants: lysine, arginine, proline, valine, leucine, isoleucine, phenylalanine, tyrosine, tryptophan and histidine. Some obvious omissions from this list were amino-acids then known as constituents of protein but the existence of which free in plants was only recognized at a later date (for example, aspartic and glutamic

acids, which when first seen were thought to be decomposition products of amides, cystine, glycine, alanine and serine). Between 1906 and 1947 a few amino-acids were newly discovered, of which methionine and threonine occurred in protein, whereas others, namely, dihydroxyphenylalanine, citrulline, canavanine, djenkolic acid and β -alanine were known to occur only in the free state.

From the first use of two-directional paper chromatography¹ in the examination of the alcohol-soluble constituents of plants, it became clear that the ninhydrin-reactive constituents far outnumber the readily recognizable constituents of protein hydrolysates. The dramatic effect of such work is only realized when the relatively simple nature of many of these compounds is appreciated and when their occurrence, often in quantity, in familiar plants is recognized. γ -Aminobutyric acid, piperidine-2-carboxylic acid, γ -methyleneglutamine, γ -methyleneglutamic acid and homoserine, to mention but a few well-chosen examples, soon became recognized as substances that occur free in plants, though their identity had passed hitherto unnoticed in the plants in which they occur. Every succeeding summary of this field of knowledge adds to the list of substances identified and also to the list of substances detected but unidentified^{2,3}.

In these circumstances, progress is not only rapid but also priorities to discoveries become difficult to establish, for, with similar lines of work being pursued in various laboratories, the ordinary channels of scientific communication become too slow and the personal letter, speeded on its way by air mail, again comes into its own as an instrument of scientific communication. The further purpose of this paper is to illustrate this point and make reference to two examples of recent discovery which have developed even as the last summary³ in this field was being written. The two examples in question concern the free occurrence of certain piperidine carboxylic acids in plants and also of certain derivatives of glutamic acid. While these subjects have in general engaged the attention of our laboratory for some time, it is proper to record that the recent events, here described, have developed around the work of one of us (N. G.) on piperidine carboxylic acids and of another (J. K. P.) on the glutamic acid derivatives.

Cyclic Imino-Acids

Pipecolic acid (piperidine-2-carboxylic acid) was one of the first substances to appear on paper chromatograms of plant extracts as an unidentified, but easily recognizable, spot (unknown No. 1, see Steward and Thompson² and Zacharius¹⁵). It was later isolated and identified from plants almost simultaneously in different laboratories⁴⁻⁶, and it is now recognized as a substance that is frequently found in legumes^{7,8}, from which it may be isolated in comparatively large quantities⁹. Moreover, the biogenesis of this substance from lysine has been established¹⁰⁻¹³.

In this laboratory a key step in the identification of the naturally occurring L(-)-pipecolic acid consisted of proving its identity with a product obtained on reducing a substance, baikiain, identified¹⁴ after isolation from the wood of a leguminous tree (*Baikiaea plurijuga*). The occurrence of pipecolic acid in the fruit and seed of the green bean (*Phaseolus vulgaris*) and the ready formation of pipecolic acid from lysine in the developing seed¹⁰ encouraged one of us (N. G.) to examine the seed of the plant *Baikiaea plurijuga*

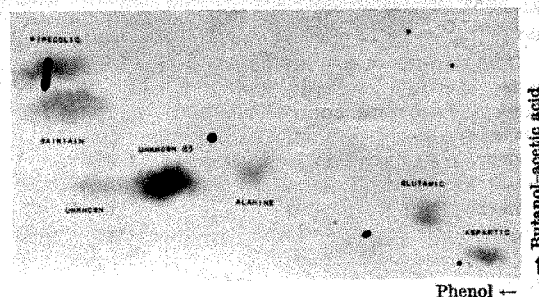


Fig. 1. Alcoholic solution of nitrogen compounds of seed of *Baikiaea plurijuga*

(Rhodesian teak). A paper chromatogram (Fig. 1) of an alcoholic extract of these seeds clearly showed, among other things, the presence of substances each having characteristic properties, as shown in Table 1.

The chromatographic characteristics of unknown No. 83 (Fig. 1) were very similar to that of a substance (unknown No. 39) previously noted in this laboratory by Zacharius¹⁵ in the seed of the honey locust (*Gleditsia trichanthos*).

From this point the substance designated above as unknown No. 83 was rapidly isolated in a state of chemical purity from the seed of *Baikiaea*. The main steps in the isolation from a 70 per cent alcoholic extract of the seed were as follows. The extract was evaporated to a syrup, hydrolysed for two hours at 120° C. in 6 N hydrochloric acid, the bulky precipitate that formed during hydrolysis was filtered off and the filtrate freed of excess hydrochloric acid by evaporation. The residue from the filtrate was dissolved in water and passed down a column containing a cation exchange resin ('Zeorex') in the H⁺ form. The adsorbed unknown No. 83 was displaced with ammonia, and the eluate containing several amino-acids, in addition to unknown No. 83, was freed of ammonia by concentration under reduced pressure. The amino-acids of the concentrate were fractionated by chromatography in water on a column of 'Amberlite XE-64', a poly-carboxylic cation exchanger in the H⁺ form. The fractions richest in unknown No. 83 were decolorized on the weakly basic 'Amberlite IR-45' ion exchange resin which was in the OH⁻ form. Unknown No. 83 was crystallized from the concentrated solution by the addition of ethanol. After two additional recrystallizations of the isolate from water by the addition of alcohol, 300 mgm. of a chromatographically pure product was obtained in the form of its free base. The compound, which does not appear to have a definite melting point, begins to decompose

Table 1

	Baikiain	Pipecolic acid	Unknown No. 83
R _F in phenol saturated with water (pH 5.5)	0.878	0.895	0.744
R _F in n-butanol : acetic acid : water (9 : 1 : 2.5 v/v)	0.178	0.214	0.113
R _F in collidine : lutidine (1 : 3 v/v) saturated with water	0.254	0.384	0.374
Fresh ninhydrin colour	yellow	red-violet	red-violet
Ninhydrin colour after 12-24 hr.	yellow	yellow-brown	yellow-brown
Fluorescence in ultra-violet light of the freshly prepared ninhydrin product	none	crimson	crimson
Colour with isatin	yellow-brown	blue-green	blue-green
Concentration (mgm./gm. of seed)	24.0	3.0	3.0

at 265° C. Its specific optical rotation was found to be $[\alpha]_D^{20} = -12.5^\circ$.

The various properties of this substance, its reaction with isatin and its general chromatographic behaviour¹⁶ were compatible with its identity as a hydroxypipicollic acid, a substance the natural occurrence of which as a derivative of hydroxylysine could almost be predicted by analogy with the biogenesis of pipicollic acid from lysine. The analysis of the isolated compound:

	C	H	N	O
Isolate (free base)	49.74	7.76	9.74	32.96
Calculated for $C_6H_{11}O_3N$ (hydroxypipicollic acid)	49.64	7.64	9.65	33.07

was compatible with this identification, and an infra-red absorption spectrum, obtained with the potassium bromide disk method, showed features that were compatible with its identity as one of the possible hydroxypiperidine carboxylic acids.

At this point one of us (F. C. S.) received from Prof. A. I. Virtanen, of Helsinki, Finland, a letter, dated August 6, 1954, in which he mentioned that 5-hydroxypipicollic acid had been isolated from a plant in his laboratory. An immediate request for the name of the plant from which this isolation had been made produced a response, dated September 15, 1954, indicating that the substance had been isolated from a palm, *Rhapis excelsa* (*Rhapis excelsa*, Thunb., Henry, is referred to by Prof. Virtanen and by Virtanen and Kari¹⁷ by the older name, *Rhapis flabelliformis*, Ait.). Thereafter, it was only a matter of hours before an extract was made to show that the leaves of *Rhapis excelsa* from the Cornell greenhouses contained the substance referred to by Virtanen as 5-hydroxypipicollic acid and that this substance was identical with the one isolated from *Baikiaea* seeds with respect to chromatographic position and colour reactions. A further request to Prof. Virtanen was promptly answered (letter dated September 23, 1954) and a few milligrams of his isolate (in the form of the hydrochloride), now isolated from the legume *Ceratonia siliqua*, was made available. With this, the chemical identity of the substance isolated from *Baikiaea* by one of us (N. G.) and the substance isolated from *Rhapis* and *Ceratonia* was established beyond all doubt by means of their infra-red absorption spectra shown in Fig. 2.

Our own desire to establish the position of the OH group in the piperidine ring had led to a request

to Prof. F. E. King, of the University of Nottingham, who had previously aided us in the identification of pipicollic acid, for a sample of the 5-hydroxypipicollic acid that he had prepared synthetically¹⁴. This elicited the prompt reply that Prof. Virtanen had already used this material to establish the identity of the substance he had isolated from *Rhapis*, etc. Parenthetically, Prof. King commented that the hydroxypipicollic acid had undergone some decomposition since its preparation.) Nevertheless, the identification of this new imino-acid from plants now depends on the work from Prof. Virtanen's laboratory. They state that under certain conditions of oxidation their isolate yields both aspartic and glutamic acids and they rely mainly on this evidence in identifying the new compound as 5-hydroxy-piperidine-2-carboxylic acid¹⁷. The identity of the material isolated in this laboratory with that of Prof. Virtanen's sample is established by the evidence which we have cited above.

It should be noted, however, that the possibilities of isomerism in the monohydroxypiperidine carboxylic acids, each with two asymmetric carbon atoms, are numerous, and it may well turn out to be an interesting question how far these possibilities are exploited in plants. A thorough study of this interesting problem awaits the preparation and resolution of all the possible hydroxypiperidine carboxylic acids.

At this point two further developments occurred. First, the existence of new hydroxy imino-acids from apples was disclosed to us by Dr. A. C. Hulme from England (letter dated February 26, 1954) and by Dr. H. S. McKee in a letter from Australia dated July 9, 1954. These appeared to be isomeric with hydroxypiperidine carboxylic acids. Samples of the isolate obtained from apple leaves in McKee's laboratory¹⁸ in Australia and from apple peel by Hulme¹⁹ in England became available in this laboratory, and infra-red scans showed beyond doubt their identity with each other and their complete distinction from the isomeric hydroxypiperidine carboxylic acids. The fact that the infra-red spectra of these acids from apple are more compatible with the pyrrolidine, rather than the piperidine, ring system, becomes important in view of the isolation of still another substance from *Rhapis*, 4-hydroxypiperidine-2-carboxylic acid²⁰, and which Prof. Virtanen was inclined to suggest could be identical with the substance from apples (letter to Dr. Hulme of January 14, 1955). It now seems quite clear that this is not so²¹.

Secondly, Gartler and Dobzhansky²² recently directed attention to the occurrence in certain human urines of a ninhydrin-reactive substance, which they did not attempt to identify, but which they showed was associated with subjects who had eaten dates. These workers found that the unidentified compound, first detected in urine, also occurs in the free state in the pericarp of dates. The chromatographic behaviour of this new compound, as described by Gartler and Dobzhansky, suggested to us that it could be a hydroxypiperidine carboxylic acid. A 70 per cent ethanol extract of the pericarp of edible dates was therefore prepared. The amino acids of the extract were adsorbed on 'Zeorex' resin and, after washing the resin with water, eluted with ammonia. A chromatogram (Fig. 3) of the partially purified amino-acid fraction clearly showed the presence in the date of baikiain, pipicollic acid and also a considerable amount of 5-hydroxypipicollic acid and even

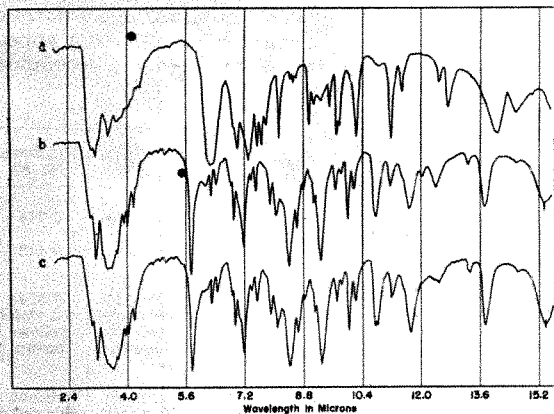


Fig. 2. The infra-red absorption spectra of 5-hydroxypipicollic acid. a, isolate (unknown No. 83) from *Baikiaea* (free base); b, isolate (unknown No. 83), from *Baikiaea* (hydrochloride); c, isolate from *Ceratonia* (hydrochloride from Prof. A. I. Virtanen)

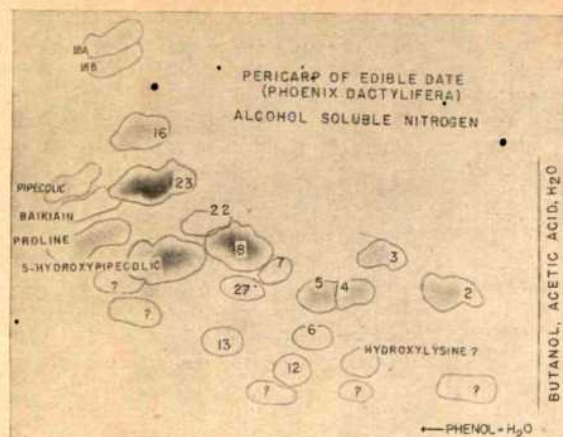


Fig. 3. Nos. follow an earlier convention (refs. 1-3). 2, Aspartic; 3, glutamic; 4, serine; 5, glycine; 6, asparagine; 7, threonine; 8, alanine; 12, lysine; 13, arginine; 16, valine; 18A, iso-leucine; 18B, leucine; 22, β -alanine; 23, γ -aminobutyric acid; 27, homoserine

the possible presence of hydroxylysine with which the latter may be biochemically interrelated.

The conclusions then are clear. Not only is piperidine-2-carboxylic acid now to be regarded as of widespread occurrence in plants, derived no doubt from lysine; but other related piperidine carboxylic acids also occur. The only partially unsaturated ones are baikiain and guvacine (the latter has long been known to be a constituent of the betel nut, *Areca catechu*). However, the occurrence of 5-hydroxy-pipecolic acid, and now the evidence that 4-hydroxy-pipecolic acid also occurs in Nature, raises numerous questions as to the metabolic role of this family of substances in both plants and animals. It is a striking testimony to the resolving power of modern chromatographic methods that this area of plant biochemistry has been so rapidly uncovered. It is also a striking testimony to the pace of discovery in this field that different laboratories can only keep abreast of this progress by the use of air mail communication.

The structural formulae of the various compounds mentioned above are shown here-with.

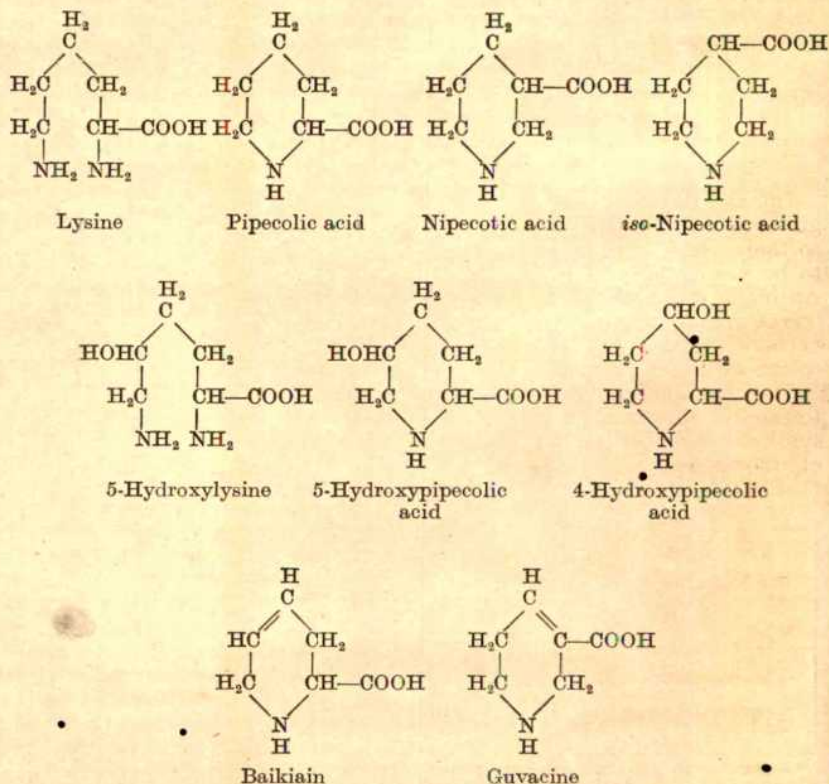
Derivatives of Glutamic Acid

One of the dramatic developments following the application of paper chromatography to the examination of the alcohol-soluble nitrogen of plants was the recognition of a third amide in plants. The chromatographic maps of Steward and Thompson² recognized the occurrence of two unidentified substances (Nos. 4 and 12) in the tulip. These were related, one to the other, by acid hydrolysis. Following the discovery of γ -methylene-glutamine in the peanut

(*Arachis hypogaea*²³), the substances in the tulip were shown to be identical with this new amide and its acid, respectively²⁴. A key point in this work was the use of infra-red methods to compare products obtained from Dr. Fowden, in England, with products isolated from the tulip. With the recognition that the keto acid corresponding to γ -methyleneglutamic acid can also occur²⁵ and with the existence of a transamination mechanism in which it could be involved²⁶, this family of substances is rapidly assuming importance in plant biochemistry. As in the case of 5-hydroxy-pipecolic acid and its related dehydro substance, baikiain, it now appears that a hydroxyl derivative corresponding to γ -methylene-glutamic acid occurs in plants. This substance is γ -methyl, γ -hydroxyglutamic acid, and its first isolation comes, strangely enough, from a fern.

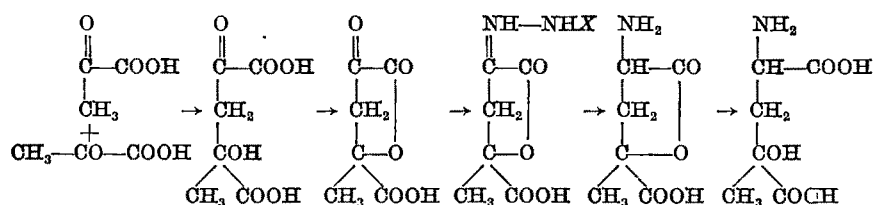
In an examination²⁷ of the nitrogenous composition of certain shoot apices of plants, carried out jointly by the Cornell and Harvard Laboratories, a curious observation was made. The bulk of the soluble nitrogen in the growing apex of the maiden hair fern (*Adiantum pedatum*) gave a strong spot, which was close to that of serine, on phenol:collidine-lutidine chromatograms. A slight shift in the chromatographic position of this compound, after acid hydrolysis, aroused the suspicion that the product might be a glutamic acid derivative, but the dramatic feature was the total amount of this substance present.

This substance was recently isolated by one of us (J. K. P.), the chief steps in the isolation from an alcoholic extract of leaves of *Adiantum pedatum* being: absorption on 'Amberlite IR-45', lution with acetic acid and evaporation to near dryness. The crystals which gradually formed in the concentrate were found to be very insoluble in cold water,



and after recrystallization from aqueous ethanol, 37 mgm. of chromatographically pure product was obtained.

From its chromatographic behaviour the isolate appeared to be a dicarboxylic amino-acid and possibly even a hydroxydicarboxylic amino-acid. The isolate gave the following elementary analysis (percentages): C, 38.59; H, 6.68; N, 7.54; O (by difference), 47.19, which is consistent with $C_6H_{11}O_5N_2H_2$, for which the percentage elementary composition is: C, 38.71; H, 6.45; N, 7.53; O, 47.31. At this point it was learned that γ -hydroxy, α -aminopimelic acid had been obtained from another fern (*Asplenium septentrionale*)²⁰. It was clear, from the elementary analysis of the *Adiantum* isolate, that this compound is not γ -hydroxy, α -aminopimelic acid. Additional proof of this was obtained by comparative paper chromatography of the compound isolated from *Adiantum* and γ -hydroxy, α -aminopimelic acid, kindly furnished by Prof. Virtanen. In these circumstances the identity of the isolate from *Adiantum* as a methyl, hydroxyglutamic acid suggested itself, and the conceivable relationship of γ -methyl, γ -hydroxyglutamic acid to γ -methyleneglutamic acid, which only differ by a mole of water, became highly suggestive. The γ -methyl, γ -hydroxyglutamic acid, by way of its lactone, was prepared from a pyruvic acid aldol condensation product prepared by the method of De Jong²⁰. (The biogenesis of γ -methyleneglutamic acid from pyruvate by condensation, dehydration and amination was regarded as a possibility from its first recognition.) By forming a hydrazone of the lactone of the pyruvic aldol, and subsequent catalytic hydrogenolysis, the corresponding amino-acid was made²⁰.



During the synthesis of γ -methyl, γ -hydroxyglutamic acid two centres of asymmetry appear and so there are four possible isomers, two of which are to be distinguished as allo and two as three forms. An obvious doubleness of the violet ninhydrin spot corresponding to the synthetic free acid could be explained in this way. The lactone, giving a brown colour with ninhydrin, shows only a single spot.

The crystalline isolate from *Adiantum* corresponds to the free acid and agrees in R_F with one of the two synthetic components, and it forms a small amount of the lactone, on standing in aqueous solution (Table 2).

Table 2

Compound	R_F values			Ninhydrin colour
	Phenol	Butanol-acetic	Collidine-lutidine	
γ -Methyl, γ -hydroxyglutamic acid*	0.217	0.068	0.197	violet
Lactone of γ -methyl, γ -hydroxyglutamic acid	0.611	0.073	0.415	brown turning olive-grey

* Crystalline isolate from *Adiantum* and one component of the synthetic acid.

While the further characterization of the isolate will require more complete treatment elsewhere, the implications of its tentative identification as γ -methyl, γ -hydroxyglutamic acid can now be discussed. Since the preparation of this manuscript it has been possible to show, by the method of Towers, Thompson and Steward²⁰, that the keto-analogue, γ -methyl, γ -hydroxy, α -ketoglutaric acid, also occurs free in *Adiantum pedatum*.

The principal soluble nitrogen compound of *Adiantum* (accounting for about 90 per cent of the soluble nitrogen in certain cases) is a new natural substance (γ -methyl, γ -hydroxyglutamic acid) the nearest relative of which would be its dehydration product, γ -methyleneglutamic acid, recently described from the peanut and the tulip. The substance also could be related to methylhydroxyproline^{19,21} by a series of feasible reactions analogous to those that lead to the formation of proline from glutamic acid via pyrrolidine carboxylic acid or glutamic γ -semialdehyde²¹. The fact that these unexpected compounds are prominent in such widely separated members of the plant kingdom would seem to indicate that they are part of some quite general feature of plant metabolism. Also the fact that in different genera of ferns two dissimilar hydroxy acids (γ -methyl, γ -hydroxyglutamic and hydroxyaminopimelic acids) have been discovered almost simultaneously emphasizes again the need to explore, by modern techniques, the nitrogen metabolism of a wider range of plants.

The expectation now is that a baffling array of relatively simple compounds may occur free in plants in addition to the amino-acids of protein hydrolysis which, as the great pioneers believed and showed,

may also occur free. In these new compounds a straight chain or cyclic structure may be substituted by hydroxyl or alkyl groups, may show saturated or unsaturated conditions, and may present in the mutual relations of the nitrogenous groups and the carboxyl groups

a far greater diversity than would have been expected hitherto.

As we have tried to show, the pace of discovery in this field is now so rapid that new observations come so fast as to outpace interpretation. Stimulating as this is, however, it should be followed by the full exploration of all the possibilities. Even though Nature may utilize but a few of the isomers, it should not be forgotten that any full understanding of the possibilities inherent in the isomeric hydroxypiperidine carboxylic acids, the hydroxymethylglutamic acids, or the methylhydroxyprolines, etc., will require much careful work in which the synthetic organic chemist and the plant biochemist should collaborate.

Inasmuch as the plant and its relation to nitrogen is of paramount importance in agriculture, nutrition and biochemistry, there can be few more rewarding areas of research to-day than the investigation of nitrogen metabolism in plants by the methods now available.

This account is based on work made possible through the Grasselli Grant to Cornell University for work being directed by one of us (F. C. S.).

The association of one of us (N. G.) with the work was made possible by a Rockefeller Foundation Fellowship at Cornell University (present address, University of Pretoria, South Africa).

- ¹ Dent, C. E., Stepka, W., and Steward, F. C., *Nature*, **160**, 682 (1947).
- ² Steward, F. C., and Thompson, J. F., "Ann. Rev. Plant Physiol.", **1**, 233 (1950).
- ³ Steward, F. C., Zacharius, R. M., and Pollard, J. K., "Biochemistry of Nitrogen", *Ann. Acad. Sci. Fenn.*, Ser. A II, *Chemica*, **N**, 60, 19 (1955).
- ⁴ Morrison, E. I., *Biochem. J.*, **50**, Proc. XIV (1952).
- ⁵ Zacharius, R. M., Thompson, J. F., and Steward, F. C., *J. Amer. Chem. Soc.*, **74**, 2949 (1952).
- ⁶ Harris, G., and Pollock, J. B. A., *J. Inst. Brewing*, **59**, 28 (1953).
- ⁷ Morrison, R. I., *Biochem. J.*, **53**, 474 (1953).
- ⁸ Zacharius, R. M., Thompson, J. F., and Steward, F. C., *J. Amer. Chem. Soc.*, **76**, 2908 (1954).
- ⁹ Grobbelaar, N., Zacharius, R. M., and Steward, F. C., *J. Amer. Chem. Soc.*, **76**, 2912 (1954).
- ¹⁰ Grobbelaar, N., and Steward, F. C., *J. Amer. Chem. Soc.*, **75**, 4341 (1953).
- ¹¹ Lowy, P. H., *Arch. Biochem. et Biophys.*, **47**, 228 (1953).
- ¹² Rothstein, M., and Miller, L. L., *J. Amer. Chem. Soc.*, **75**, 4371 (1953).
- ¹³ Schweet, B. S., *J. Biol. Chem.*, **208**, 603 (1954).
- ¹⁴ King, F. E., King, T. J., and Warwick, A. J., *J. Chem. Soc.*, 3590 (1950).
- ¹⁵ Zacharius, R. M., Ph.D. thesis, Univ. of Rochester, N.Y. (1952).
- ¹⁶ Grobbelaar, N., Ph.D. thesis, Cornell Univ., Ithaca, N.Y. (1955).
- ¹⁷ Virtanen, A. I., and Kari, S., *Acta Chem. Scand.*, **8**, 1290 (1954).
- ¹⁸ Urbach, G., *Nature*, **175**, 170 (1955).
- ¹⁹ Hulme, A. C., *Nature*, **174**, 1055 (1954).
- ²⁰ Virtanen, A. I., and Kari, S., *Acta Chem. Scand.* (in the press).
- ²¹ Hulme, A. C., and Steward, F. C., *Nature*, **175**, 171 (1955).
- ²² Gartler, S., and Dobzhansky, T., *Nature*, **174**, 553 (1954).
- ²³ Done, J., and Fowden, L., *Biochem. J.*, **49**, Proc. XX (1951).
- ²⁴ Zacharius, R. M., Pollard, J. K., and Steward, F. C., *J. Amer. Chem. Soc.*, **76**, 1961 (1954).
- ²⁵ Towers, G. H. N., and Steward, F. C., *J. Amer. Chem. Soc.*, **76**, 2392 (1954).
- ²⁶ Fowden, L., and Done, J., *Nature*, **171**, 1068 (1953).
- ²⁷ Steward, F. C., Wetmore, R. H., Thompson, J. F., and Nitsch, J. P., *Amer. J. Bot.*, **41**, 123 (1954).
- ²⁸ Virtanen, A. I., Uksila, E., and Matikkala, E. J., *Acta Chem. Scand.*, **8**, 1091 (1954).
- ²⁹ Towers, G. H. N., Thompson, J. F., and Steward, F. C., *J. Amer. Chem. Soc.*, **76**, 2392 (1954).
- ³⁰ De Jong, A. W. K., *Rec. trav. chim. Pays Bas*, **19**, 81 (1900).
- ³¹ Vogel, Henry J., and Bonner, David M., *Proc. U.S. Nat. Acad. Sci.*, **40**, 688 (1954).

OBITUARIES

Dr. G. M. Lees, F.R.S.

DR. GEORGE MARTIN LEES, until recently chief geologist to the Anglo-Iranian Oil Company, died on January 26 at the age of fifty-six. He had a friendly virile personality, boundless vitality and exceptional powers of understanding and constructive thought. He was a strong protagonist of full and early publication of scientific results acquired in commercial exploration, particularly in Britain; his death is a great loss to geological science and to its practical application.

Born on April 16, 1898, the son of George Murray Lees, of Edinburgh, he was educated at St. Andrew's College, Dublin, and proceeded to the Royal Military Academy, Woolwich, whence he was commissioned in the Royal Artillery in 1915; he served in France, winning the M.C., and afterwards he transferred to the Royal Flying Corps. Following a period as flying instructor in Egypt, he saw further service in Iraq, where he won the D.F.C. When hostilities ceased he joined the civil administration of Iraq and was appointed assistant political officer in Southern Kurdistan during a lively period in the history of that province.

Lees's entry to geology came with his accepting in 1921 the offer of a post as assistant geologist with

the Anglo-Iranian Oil Co., Ltd., and he set about learning geology in the course of his duties, attending occasional courses at the Royal School of Mines during his leave periods. His first three years as a geologist were spent on fruitful surveys in south-west Persia, for a time in association with H. de Boeckh; in 1925 he undertook a classic survey of Oman, and he secured for the Anglo-Iranian an option on the oil-rights of Qatar from the shahk of that territory. A year's study leave at the University of Vienna resulted in the award of a Ph.D. for his thesis on the geology of Oman, which brought much new stratigraphical and structural information to its subject. After serving in all countries where exploration by his Company was then practicable, Lees was made chief geologist in 1930. At that time the Anglo-Iranian had but three producing oil-fields in the Middle East; exploitation, however, soon increased, and geological exploration expanded not only there but also in New Guinea, Trinidad and Nigeria, and after the Second World War new ventures were started in Sicily, Switzerland and East Africa. So Lees travelled extensively and developed a wide and intimate geological knowledge of many and varied problems, particularly in the field of structural geology.

Meanwhile, since 1930 and in the face of criticism bordering upon ridicule, Lees had been pressing the directors of the Anglo-Iranian to have a systematic search for oil conducted in Britain, and in this search he took a leading part. Prospecting licences were taken out in 1935 and several borings were drilled; but though useful geological information was obtained, commercial success was not achieved until in 1939, on the basis of a seismic survey, the first well was drilled at Eakring in Nottinghamshire. Further exploration proved the Eakring structure to be one of three closely associated domes arranged in echelon, each with a considerable accumulation of oil in Upper Carboniferous sandstones some 2,000 ft. below the surface. More than a hundred and eighty wells came into production at Eakring, and with the nearby Kelham Hills and Cauntun wells first drilled in 1941 and 1943 an annual production of up to 100,000 tons of good oil was reached when oil was most needed for the British war effort. These fields are still in production to-day. Extensive exploration by boring, accompanied by geophysical work, continued in many parts of Britain and resulted in an enormous amount of new and well-documented information concerning the underground geology of the country. These results were communicated to the Geological Society in 1937 and 1944. That Society awarded its Bigsby Medal to Lees in 1943, and some years later elected him as its president; thus he became the first geologist practising his profession in industry to receive this distinction. His presidential addresses on "Foreland Folding" (1952) and "The Evolution of a Shrinking Earth" (1953) dealt with fundamental concepts and were characteristically thoughtful and ingenious. Lees was elected a Fellow of the Royal Society in 1948 and, shortly after his retirement from active service with the Anglo-Iranian Oil Co., early in 1954, the American Association of Petroleum Geologists awarded him the Sidney Powers Memorial Medal.

His remarkable knowledge, shrewdness, good humour and skill of exposition had powerful influence in the counsels of the Anglo-Iranian Oil Co. and those of the learned societies to which he belonged. These same attributes were profitably used by the Boards

of the Geological Survey and of the Colonial Geological Surveys, of which he was a valued member.

He married Hilda Frances, daughter of E. B. Andrews, of Birmingham, in 1931, and they had one son.

C. J. STUBBLEFIELD

Dr. C. E. Larard

CHARLES EDWARD LARARD, whose death occurred on September 23, was for many years head of the Department of Civil and Mechanical Engineering in the Northampton Polytechnic, London. He served his apprenticeship at the Vulcan Iron Works, remaining with this firm afterwards for some time as chief draughtsman. His early scientific and technical training took place at the Hull Technical Institute. Later, at the Andersonian College, Glasgow, under Prof. Humboldt Sexton, he studied for an honours course in practical metallurgy, after first taking honours in practical chemistry. He continued his studies at the University of Manchester, and for a short time at the Royal College of Science and Technology, London, where he gained a free studentship and Royal Exhibition: these he resigned in order to obtain specialized instruction elsewhere.

For one year Dr. Larard was lecturer for the Carron Iron Works, Stirlingshire, and for the following four years he held a post as lecturer in the Civil and Mechanical Engineering Department at the

Battersea Polytechnic, London. He was then appointed head of the Civil and Mechanical Engineering and Architectural Departments of the Huddersfield Technical College, a post which he held for more than three years; during this time he equipped the Engineering Department and founded the Huddersfield Engineering Society, of which he was the first president.

In 1902, Dr. Larard became head of the Civil and Mechanical Engineering Department of the Northampton Polytechnic, London—a post which he held for thirty-two years, until his retirement in 1934. During this period he was a member of the Board of Studies in Civil and Mechanical Engineering and a member of the Faculty of Engineering in the University of London. He was also a member of the British Standards Institution.

During the First World War, Dr. Larard was director in charge of the workshops at the Northampton Polytechnic, which supplied high-precision gauges and gun parts for the Admiralty, War Office and other government departments, and in addition he carried out work on aeroplane construction on behalf of the Admiralty and the Aeronautical Inspection Department.

Dr. Larard's father, Charles Larard, was also a mechanical engineer, and his own eldest son, Charles Kenneth, a chartered civil engineer, is at present chief engineer to Messrs. Butterfield and Swire in Hong Kong and the Far East.

NEWS and VIEWS

Rockefeller Foundation, New York

THE ROCKEFELLER FOUNDATION, New York, has recently been reorganized so as to bring its various activities into closer relationship with one another. Dr. Alan Gregg continues as vice-president on special assignments, Dr. Lindsley F. Kimball, a vice-president of the Foundation since 1949, is now executive vice-president, and Dr. Warren Weaver has been appointed vice-president for the natural and medical sciences.

The previous organization of the Foundation into divisions has been changed to one in which the responsibility for its programme is placed in the hands of five directors as follows: Dr. Norman S. Buchanan, social sciences; Dr. John C. Bugher, medical education and public health; Dr. Charles B. Fahs, humanities; Dr. J. George Harrar, agriculture; and Dr. Robert S. Morison, biological and medical research. Dr. Buchanan, who will take up his appointment in July, succeeds Dr. Joseph H. Willits, who retired last year; Dr. Buchanan was associate director for social sciences during 1947–50 and is at present professor of economics in the University of California. Dr. Bugher is on leave from the Foundation for four years, serving as director of the Division of Biology and Medicine of the United States Atomic Energy Commission, and by special arrangement will continue on the Commission for a further period; before joining the Foundation in 1951 he had been for five years director of the Yellow Fever Institute in Lagos, Nigeria. Dr. Fahs continues as director in charge of the humanities programme of the Foundation, in which capacity he has served since 1950. Dr. Harrar joined the Foundation in 1943 as local rector for the agricultural programme in Mexico and was appointed deputy director for agriculture in

1952. Dr. Morison, who has been assistant and associate director of medical sciences in the Foundation since 1944, was previously teaching in the Departments of Physiology and Anatomy of Harvard Medical School. The three directors concerned specifically with the natural sciences, Drs. Harrar, Morison and Bugher, will be working in co-operation with Dr. Weaver, who, as vice-president for the natural and medical sciences, will be responsible for developing, co-ordinating and supervising all the Foundation's activities in science. Director of natural sciences and agriculture since 1932, Dr. Weaver is a distinguished mathematician and is retiring president and chairman of the board of the American Association for the Advancement of Science.

The reorganization is in keeping with the fact that for a number of years the primary emphasis in the Rockefeller Foundation's programme in the natural sciences has been upon modern experimental biology. But this does not mean that mathematical and physical sciences are being neglected, for a special feature of the biological programme has been to utilize the application of mathematics, physics and chemistry to basic biological problems; occasional grants strictly in the physical sciences have also been made from time to time. As one who has been trained in mathematics and physics, this continuing interest in the physical sciences will be a special responsibility of Dr. Weaver himself.

Royal Meteorological Society: Symons Memorial Gold Medal

THE Symons Memorial Gold Medal of the Royal Meteorological Society, which is awarded biennially for distinguished work in meteorological science, has

been conferred this year on Dr. R. C. Sutcliffe, a deputy chief scientific officer in the Meteorological Office, for his outstanding work in the field of synoptic and dynamical meteorology. The award was made at the annual general meeting of the Society on April 20. The citation stated: "Dr. Sutcliffe's success as a practical weather analyst and forecaster is matched by his achievements as a practical theorist and teacher. To his fundamental researches we owe a great deal of our knowledge of the effect of temperature patterns on development. His two-layer model of atmospheric motion has become the basis of a practical method of numerical weather forecasting. To his ability and enthusiasm is due in large measure the remarkable success of the Napier Shaw Laboratory. His engaging popular style combined with his seriousness of purpose have made him one of the most successful teachers and there can be few meteorologists whose understanding has not been deepened and broadened as a result of his efforts".

Canadian Award in Meteorology:

Dr. John Patterson, O.B.E.

IN 1947, shortly after Dr. John Patterson's retirement from the post of controller of the Canadian Meteorological Service, a fund was established by donations from his many friends and associates, from which a Patterson Medal is to be awarded annually to a Canadian resident for distinguished service to meteorology. The fund is held in trust by a group of the senior officials in the Canadian Meteorological Service, who will annually appoint an award committee composed of representatives from the Meteorological Service, research institutions, Canadian universities and Canadian industry. The first award of the Medal has recently been made to Dr. Patterson himself. Dr. Patterson, who is eighty-three, was controller of the Canadian Meteorological Service during 1929-46. He graduated from the University of Toronto in 1900, with the gold medal in physics, and was then awarded an 1851 Exhibition Science Research Scholarship which took him to England for two years at the University of Cambridge. He later became professor of physics in the University of Allahabad for two years, after which he was appointed head of the Indian Weather Service. He joined the Canadian Weather Service in 1910. During his association with the Service, Dr. Patterson contributed to the design of a series of instruments especially suited to rugged Canadian weather conditions, and under his guidance the Service expanded rapidly, in keeping with the heavy demands placed upon it by the British Commonwealth Air Training Plan of the Second World War. He is known internationally for his personal interest and leadership in the World Meteorological Organization and other scientific societies.

Upper Atmosphere Research by the National Research Council of Canada

DR. PETER M. MILLMAN, formerly chief of the Stellar Physics Division of the Dominion Observatory, Canada, has joined the National Research Council of Canada and will work in the Division of Radio and Electrical Engineering, leading the section on upper atmosphere research. Dr. Millman, who was born in Toronto in 1906, graduated from the University of Toronto in 1929, and then took a Ph.D. in astronomy at Harvard University in 1932. During 1933-45 he was on the staff of the David Dunlap Observatory

and lecturer in astronomy, University of Toronto, and since then he has worked at the Dominion Observatory, being chief of the Stellar Physics Division since 1951. During 1941-46 he was in the Royal Canadian Air Force, first as a navigation instructor and later in charge of operational research, retiring with the rank of squadron leader. Dr. Millman's investigations for the past twenty years have been concerned mainly with meteors and meteorites; but he has also worked in the field of stellar radial velocities and in the observation of solar eclipses from the air.

Martin Barry (1802-55)

MARTIN BARRY, who died one hundred years ago on April 27, 1855, is an interesting example of an amateur who made valuable contributions to science. Born at Fratton, in Hampshire, on March 28, 1802, he studied medicine in Paris, Erlangen, Berlin, Edinburgh and London, and graduated M.D. of the University of Edinburgh in 1833. In the following year, while on a visit to Switzerland, he climbed Mont Blanc in mid-September—later in the season than any successful attempt previously recorded—and published a paper "On Dyspnoea and other Sensations experienced on the Summit of Mont Blanc" in the *Proceedings of the Royal Society of Edinburgh*. For a year he studied embryology under Friedrich Tiedemann at Heidelberg, and his "Researches in Embryology" (1838-40) won him one of the Royal Medals of the Royal Society in 1839; he was elected a Fellow in 1840. Barry is principally known for two fundamental discoveries: the segmentation of the yolk in the mammiferous ovum obtained from the Fallopian tube, and the penetration of spermatozoa within the zona pellucida of the rabbit's ovum. While the ovum and spermatozoon had each been known for many years, their union in the process of fertilization had so far remained conjectural. Barry observed an orifice in the zona pellucida, its form "suggesting the idea of the membrane having become cleft", and described within it some five hours after coitus, "an object very much resembling a spermatozoon". His findings, doubted at first, were afterwards confirmed by T. L. W. Bischoff and others. Barry was one of the first in 1840 to note proliferation of cells by division of the nucleus and cytoplasm. In 1844 he became house-surgeon to the newly founded Royal Maternity Hospital in Edinburgh; but, his health failing, he returned to the Continent of Europe where he cultivated his intimate friendship with Johannes Müller, Theodor Schwann, Rudolph Wagner, J. E. Purkinje and G. G. Valentin. In 1851 he settled at Beccles in Suffolk, his sight almost ruined by the strain of microscopic work, and a victim of neuralgia and insomnia. He died at the early age of fifty-three.

Poliomyelitis Vaccine Tests in Great Britain

THE Medical Research Council has announced that a limited amount of anti-poliomyelitis vaccine similar to that used in the United States, will be available to the Council this year and that small groups of children will be vaccinated in a few centres in Great Britain and Northern Ireland, where there are laboratories engaged in studying the poliomyelitis virus. By means of blood tests on the vaccinated children, information on the response of the vaccine will be obtained, and this will be compared with the information obtained from laboratory tests. The results will be used for planning the most effective use of the larger quantities of vaccine which

are likely to become available in Britain in 1956. It is emphasized by the Council that the vaccine is at present available only for these limited purposes, and that applications for inoculation cannot be entertained.

Gravity Survey in the South Atlantic and Indian Oceans

GRAVITY surveys are to be made during a training cruise by H.M. Submarine *Acheron* to Trincomalee via the Cape of Good Hope and back through the Mediterranean. Observations will be made by Lieut. J. C. Harrison, R.N.V.R., a 25-year-old National Service officer who, after taking his degree at Cambridge, went to the University of California. From the coast of California he has recently made some half-dozen cruises in U.S. submarines in the course of which gravity surveys have been made. Three gravity surveys organized by the Department of Geodesy and Geophysics at Cambridge have previously been made in British submarines in Home and Mediterranean waters. They have been organized through the Defence Services Research Facilities Committee of the Royal Society. The forthcoming gravity survey will be in the South Atlantic and Indian Ocean, and it is in response to a resolution of the General Assembly of the International Union of Geodesy and Geophysics requesting all maritime powers to carry out so far as possible soundings and gravity measurements in those of the oceans which have not yet been explored. The Admiralty will be paid for the additional expenses resulting from the scientific work. The *Acheron* was expected to leave Portsmouth on April 20, and to return to the United Kingdom in about six months.

The Future of the Norfolk Broads

In replying to Mr. John Parker in an adjournment debate in the House of Commons on March 25, when the question of making the Norfolk Broads into a national park at an early date was raised, Mr. Hugh Molson, the joint parliamentary secretary to the Ministry of Transport and Civil Aviation, gave a useful statement of the present position. He stated that the matter had been considered by the National Parks Commission, set up in December 1949, which early reached two fundamental conclusions: first, that it would be unwise to designate the area without a clear prospect that the deterioration to which Mr. Parker referred could be halted; and secondly, that although the Act permits the Minister to pay a 100 per cent. grant on waterways expenditure, it is reasonable that local interests, who will benefit from the work done, should contribute.

In April 1951 the National Parks Commission asked the then Minister for Housing and Local Government whether it could count on a contribution of, say, £230,000 a year from the Treasury towards the work that would be required. An extensive survey carried out by one of the Ministry's engineering inspectors in the following summer confirmed that the expenditure to make a thorough job would not be less than £750,000 and might well be £890,000 for a period of twenty years with considerable maintenance costs, and that not less than four million tons of silt would require to be deposited upon the adjoining agricultural land. After considering this report, the Ministry, in January 1953, informed the Commission that any scheme involving works on this scale must, for the time being, be regarded as out of the question. Mr. Molson added

that the Nature Conservancy, and probably also the landowners, are opposed to the dumping of large quantities of silt upon the banks of the Broads, and the Ministry of Agriculture and Fisheries is concerned as to the effect of such dumping on fertility.

Mr. Molson said that he was not able to anticipate the Chancellor of the Exchequer's promised statement regarding the availability of the Land Fund for such purposes. There are, he thought, three possibilities. One is to designate the Broads as a national park and undertake the expenditure involved in the large-scale dredging. Secondly, the area could be designated in the hope that a certain amount of money might be available for some of the purposes required, and this the Commission would clearly consider. The third possibility is to leave matters as they are so far as the Government is concerned. Mr. Molson understood that local interests are doing some work at the present time and that some amenities which are of the greatest importance are being preserved. The matter is constantly under consideration by the National Parks Commission, which is in touch with the Ministry of Housing and Local Government on the subject, and technical difficulties make it uncertain at least whether the work could be satisfactorily carried out even if a large sum of money were available. In opening the debate, Mr. Parker cited the recent estimate that at least half an inch of deposit is added to the bottom of every Broad each year, that deterioration has proceeded much more rapidly in Broads closed to the public than in those still open, and that there is also some silting up of the through waterways. The 2,600 acres of open water in the Broads at the time of the Hobhouse Committee's Report is to be compared with three thousand acres fifty years ago and four thousand acres a hundred years ago.

First Forest Park in Northern Ireland

THE first forest park in Northern Ireland, Tollymore Park in County Down, will be open to the public from May 1. The Park, which covers an area of about twelve hundred acres, is beautifully situated at the foot of the McBurne Mountains, and the River Shimna runs through the forest, which was formerly owned by the Earl of Roden. The decision to create the Park has been taken under the Forestry Act (Northern Ireland) 1953, which empowers the Ministry of Agriculture to declare that any land owned by the Ministry shall be treated as a forest park, to which the public shall have access in accordance with by-laws. The Ministry proposes to open the Park to camping parties from youth organizations, and there will also be parking sites for about twenty caravans.

Russian Comfrey as a Crop

SINCE Russian comfrey (*Symphytum peregrinum*) was first introduced into Great Britain in 1870, its agricultural value has been a matter of some controversy. To secure more definite information regarding cultivation of this crop, and the methods for conserving and feeding it, a number of trials were carried out in 1954 in Great Britain and overseas under the aegis of the Henry Doubleday Research Association, Bocking, Braintree, Essex. The conclusions of these trials have been published by the Association under the title of "Russian Comfrey Report No. 1: The 1954 Research Results", by Lawrence D. Hills (pp. 36+5 plates; 1955; 3s.). The plant is a perennial, and, when established, will

produce a large bulk of foliage of high protein and low fibre content. The total yields from successive cuts recorded in the British trials average just over 25 tons per acre per annum, though much higher figures have been claimed on previous occasions. As with other crops, success depends on good management, and the report includes recommendations for its cultivation, stressing the need for keeping the land clean, well manured and the crop regularly cut. The most profitable stock to feed with comfrey are pigs and poultry, though horses also appear to thrive on it. Information regarding conservation is scanty; but methods of drying and making silage are under investigation. The perennial nature of the crop renders it difficult to fit in with ordinary rotations on a farm, and once established it is difficult to eradicate. Instructions are supplied in an appendix to deal with this latter contingency. The plant might, however, prove useful to the smallholder or poultry keeper.

Biology and Human Affairs

In November 1954 the joint committee of the various biological societies of Britain held a conference on endocrinology. In one of the papers, Dr. Thaddeus Mann examined the experimental approach to endocrinology, while in another Dr. H. Gardiner-Hill discussed endocrinology from the clinical point of view. These two papers have been reprinted in the current issue of *Biology and Human Affairs*, which also contains an article by Dr. H. A. Barnicot on biological variation in human populations (20, No. 2; February 1955). The journal also contains details of the British Social Biology Council's Summer School which, this year, will be held during August 15-29 at Driebergen in Holland. The School is to be divided into two study groups, one of which will examine the application of biological knowledge in agriculture and food production, and the other will investigate the social services in Holland, particularly in relation to health, child welfare and problem families. Further information about the School can be obtained from the British Social Biology Council, Tavistock House South, London, W.C.1.

National Museum of Canada: Annual Report for 1952-53

THE annual report of the National Museum of Canada for 1952-53 (pp. 313+18 plates. Ottawa: Queen's Printer, 1954; 1.50 dollars) records a large number of field investigations and the collection of many specimens, the continuation of certain research projects and the initiation of new ones, the improvement and enlargement of certain exhibits, and the continuation of the educational programme. But in addition to these normal museum functions, and in common with many museums of the British Commonwealth, the report contains ten original illustrated papers by members of the staff. The subjects include anthropology and folk-lore (Marcel Rioux), a new species of Eurypterid from the Devonian of Gaspé (Louis S. Russell) and lichens of Cape Breton Islands (I. Mackenzie Lamb). All these subjects reflect the many interests of this national Museum.

Royal Society Depository of Unpublished Mathematical Tables

THE following is a list of accessions to the Royal Society's depository of unpublished mathematical tables since the publication of the last list in *Nature* (173, 1221; 1954):

(42) Integrals of the types

$$M_{p,q}(a) = \int_0^a \frac{J_p(x) J_q(x)}{x^{p+q}} dx$$

$$\text{and } N_{p,q}(a) = \int_0^a \frac{I_p(x) I_q(x)}{x^{p+q}} dx$$

(Marconi's Wireless Telegraph Co., Ltd.);

(43) (i) Étude de $N = 5n^4 + 1$ et $N = 5n^4 - 1$

(ii) Étude de $N = 10n^4 - 1$ et $N = 10n^4 + 1$ (A. Ferrier);

(44) A generalized off-set circle probability distribution;

(45) Tables of $n = (m^2 + i)^{1/2}$;

(46) Tables of $|I| = \left| \int_0^\varphi \sec \theta \exp i\mu \sec \theta d\theta \right|$;

(47) Tables of functions associated with the Airy integral (M. Rothman);

(48) Table of two-fifths powers (Royal Aircraft Establishment);

(49) Étude de $N = 3n^2 - 1$ et $N = 3n^2 + 1$ (A. Ferrier);

(50) Étude de $N = 2^n \pm a$ (A. Ferrier);

(51) Numerical data relating to the flow of heat in tubes (A. K. Jenkins).

Tables 44-46 were compiled by the Admiralty Research Laboratory.

Further information about these tables can be obtained from the Assistant Secretary, Royal Society, Burlington House, London, W.1.

Royal Institution: Programme of Lectures

THE programme of Friday Evening Discourses at the Royal Institution, Albemarle Street, London, W.1, for the after-Easter session covers as usual a wide range of subjects. The Discourses, which are now in their 130th year since Faraday first started them, begin on April 29 with a discourse by Mr. George Rylands on "Parts of Poetic Speech". The next two discourses will both be illustrated by experiments and demonstrations in the tradition of the Royal Institution. On May 6, Dr. F. P. Bowden, of the Department of Physical Chemistry, Cambridge, will talk on "Fast Reactions in Solids and the Birth and Growth of Explosions". On May 13, Prof. R. W. Douglas, of the Research Laboratories, General Electric Co., Ltd., recently appointed professor of glass technology in the University of Sheffield, will be speaking on "The No-man's Land between Conductors and Insulators". Sir Wilfrid Le Gros Clark is to speak on May 20 on "The Exposure of the Piltdown Forgery". After Whitsun, Sir Hugh Casson, director of architecture at the Festival of Britain, will be talking about his recent trip to Peking. This will be on June 3. The next discourse, on June 10, will be given by Sir Graham Sutton, director of the Meteorological Office, on "Weather Forecasting—the Future Outlook". The session will end on June 17, when Sir Harold Spencer Jones, Astronomer Royal, will speak on the plans for the International Geophysical Year, 1957-58. In addition to the discourses, Sir Lawrence Bragg will deliver one afternoon lecture on May 3 for fourth- and fifth-form pupils from London schools. This lecture will be on "Famous Scientists in the Royal Institution" and will be illustrated by experiments which were originally performed by Rumford, Young, Davy, Faraday, Tyndall and Dewar. The requests to attend this lecture have been so many that Sir Lawrence Bragg has agreed to repeat it or

May 4, 17 and 18. Thus some two thousand children will have had the opportunity of seeing these famous experiments performed in their original setting.

Summer School on Computers

A FOUR-WEEK course on digital and analogue computers and their application to electrical engineering problems will be given at the Imperial College of Science and Technology, London, during May 31–June 24. The course is intended to acquaint electrical engineers with the computing facilities that are becoming available, to introduce them to the methods used for the solution of typical engineering problems, and to instruct them in the presentation of problems for computation. It is being given by the Department of Electrical Engineering with the help of the Mathematics Department of the College, members of the staff at the National Physical Laboratory and various firms and organizations engaged in computer manufacture and application. Further information can be obtained from the Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7. The number attending the course will be restricted to about twenty.

Royal Irish Academy

THE following have been elected members of the Royal Irish Academy: Prof. W. D. Gill, professor of geology and mineralogy, University of Dublin; Rev. F. J. B. Jennings, *O.F.M.*; H. E. Kilbride-Jones, archaeologist; Prof. J. J. McHenry, professor of experimental physics, University College, Cork; E. M. Patterson, geologist, Imperial Chemical Industries, Ltd.; Dr. W. F. Pyle, reader in English and fellow of Trinity College, Dublin; Prof. D. E. W. Wormell, professor of Latin and fellow of Trinity College, Dublin.

University College of Rhodesia and Nyasaland

APPOINTMENTS to the following chairs have been made in the University College of Rhodesia and Nyasaland: *Agriculture*, Dr. A. G. Davis, reader in agronomy in Wye College, University of London; *Botany*, Prof. A. S. Boughey, formerly professor of botany in the University College of the Gold Coast; *Physics*, Dr. E. Leighton Yates, senior lecturer in physics in the University of Sheffield; and *Education*, Dr. H. J. Rousseau, formerly head of the Department of Education in the University College of Fort Hare, South Africa.

Chemical Society: Officers

OFFICERS of the Chemical Society have been elected as follows: *President*, Prof. W. Wardlaw; *Vice-Presidents*, Sir Ian Heilbron, Sir Cyril Hinshelwood, Prof. C. K. Ingold, Dr. W. H. Mills, Sir Eric Rideal, Sir Robert Robinson, Prof. R. D. Haworth, Prof. E. R. H. Jones, Prof. R. P. Linstead, Prof. H. W. Melville, Prof. M. Stacey and Sir Alexander Todd; *Honorary Treasurer*, Mr. M. W. Perrin; *Honorary Secretaries*, Prof. E. D. Hughes, Dr. L. E. Sutton and Prof. F. Bergel; *New Members of Council*, Dr. D. W. Adamson, Dr. G. R. Barker, Prof. F. Bell, Dr. A. Hickling, Dr. A. W. Johnson, Dr. A. Maccoll, Dr. F. H. Pollard, Dr. W. Wild and Dr. G. T. Young.

Social Research in Industry: Meeting in York

THE ACTON SOCIETY TRUST and the York Civic Trust are jointly holding a meeting in York during

April 23–27 on social research in industry which will be similar to that held in York in October 1953. Half the participants at the meeting will be from abroad, nine countries in Europe being represented, and they will all be workers in sociology, psychology or anthropology actively engaged in studies of the behaviour of individuals or organizations in industry. The discussions will be both on actual pieces of research carried out and on problems of interest to research workers everywhere, such as achieving co-operation in industry and getting the results of research translated into action.

Announcements

H.R.H. THE DUKE OF GLOUCESTER will inaugurate the 15-MeV. linear accelerator at Saint Bartholomew's Hospital, London, E.C.1, on April 27. The equipment will be used for radiotherapy and radiobiological research.

WE regret to announce the death of Prof. Albert Einstein, *For.Mem.E.S.*, of the Institute for Advanced Studies, Princeton, aged seventy-six.

THE British Coal Utilization Research Association at Leatherhead will hold open days on June 8–10, during which the work of the laboratories will be available for inspection by visitors; June 8 will be reserved for members of the Association and their friends.

THE seventh of the annual Symposia on Phyto-pharmacy and Phytiatry will be held in the Agronomic Institute, Ghent, during April 26–27, under the presidency of Prof. J. Van den Brande, rector of the Institute. Further information can be obtained from the Secretary of the Symposium at the Rijkslandbouwhogeschool, Coupure 233, Gent.

THE third assembly of the Israel Medical Association will be held in Israel during August 10–20, with sessions in Jerusalem, Haifa and Tel Aviv. An organized tour from Britain arranged in connexion with the meeting leaves London on August 8. Details, including the preliminary scientific programme, can be obtained from D. F. Long and Co., Travel House, Mornington Crescent, London, N.W.1.

THE Yorkshire Group of the Library Association has prepared a list of translators in Yorkshire (East and West Ridings), containing details of sixty-two translators arranged in alphabetical order, with language, place and subject indexes. The list is not comprehensive, as some translators were not prepared to take on additional work. Details of qualifications and experience, etc., have been supplied by the translators themselves. The list can be obtained from the Group Honorary Treasurer, at the Commercial Library, Bradford 1, price 2s. 6d.

A CONFERENCE on Airglow and Auroræ is to be held at The Queen's University, Belfast, on September 6 and 7, that is, immediately after the Dublin assembly of the International Astronomical Union. Prof. S. Chapman will preside. Less time than is customary will be devoted to the reading of papers, the primary purpose of the Conference being to provide observers and theoretical workers who are actively engaged in the field with an opportunity of meeting and exchanging views on problems of common interest. Those wishing to have an invitation to attend should communicate with Prof. D. R. Bates or Dr. A. Dalgarno, Department of Applied Mathematics, The Queen's University, Belfast.

USE OF COLOURING MATTERS IN FOODS

THE addition of colour to food is common practice; but many colouring substances are toxic and some have already been prohibited. The main issue before the Food Standards Committee set up by the Ministry of Food* was whether the public health would best be safeguarded by extending the present list of prohibited colours or by introducing a list of permitted colours. At first it considered recommending the adoption of the list approved in the United States and Canada; but representation was made to it that "this list would be insufficient to meet the present needs of the food industry in this country". The United States list contains nineteen colours; the colours in use in Britain at the present time number seventy-nine.

The Committee came to the conclusion that "the present Regulations under which in practice almost all known synthetic colours can be used in foods are unsatisfactory", and it states that "a review of scientific literature reveals that for only comparatively few colours is there information as to chronic toxicity or carcinogenicity". It is disturbing to note that, out of the list of seventy-nine colours at present in actual use, the Committee found it necessary to recommend the rejection of thirty-five "because examination of the experimental evidence shows that they have definitely harmful effects on health, or that their chemical structure includes groupings likely to be set free in the body which have been shown to cause cancer or other harmful effects in animals or man". Only twelve out of the seventy-nine seemed definitely safe, the remaining thirty-two being colours "about which there was no direct

evidence of toxicity or harmfulness" but about which there was equally room for doubt.

The Committee states that it has not been able to meet in full the stated requirements of the trade; but there is no doubt that it has gone as far as it could without subjecting the public to quite unnecessary risks, and it includes a recommendation that provision be made for additions to or deletions from the list as further information becomes available.

In view of the widespread use of colourings, it is perhaps not surprising that the Committee should so readily accept the need to continue to permit the use of at least some; but from a nutritional point of view there is much to be said against the practice, quite apart from any danger of toxicity. One can agree with the Committee that "it is generally accepted to be physiologically sound that food should be presented in as attractive a form as possible" and perhaps also that "without the addition of colour many foods would have a drab unattractive appearance". It should, however, be stressed that a drab unattractive appearance indicates a poor standard of catering and is commonly produced by methods of cooking which greatly lower the nutritive value of the food being cooked. If, for example, fish looks drab, let it be served with tomatoes or a naturally green vegetable; these will greatly add to the nutritive value of the meal, whereas dyeing the fish will not. Processing and cooking methods which give a high nutritive value to the food do not require the addition of dyestuffs to make the products attractive. It is necessary to emphasize, far more than the Committee has done, that colourings can be used "to mask the use of inferior ingredients and to give a false impression of quality".

M. W. GRANT

* Ministry of Food. Food Standards Committee Report on Colouring Matters; Recommendations relating to the Use of Colouring Matters in Foods. Pp. 27. (London: H.M.S.O., 1954.) 1s. net.

SECOND INTERNATIONAL CONGRESS OF FILMOLOGY, PARIS

IT has been found necessary to coin a word to distinguish the study of the film in all its aspects from more limited forms of film study—such as study from the aesthetic angle or study directed towards film-making. Like 'musicology', the term 'filmology' seems to have become established. The Institut de Filmologie, under the double sponsorship of the Faculty of Letters and the Faculty of Science, was founded in the University of Paris in 1948. A course in filmology is provided, and a diploma granted for this subject.

The Second International Congress of Filmology was held in the University of Paris during February 19–23, under the presidency of M. Mario Roques. The executive delegate was M. G. Cohen-Séat (who is the director of the Institut de Filmologie), and the convener was Dr. W. D. Wall, of the Department of Education, Unesco; the presidents of the two Congress Sections were Prof. A. Michotte van den Berck, of the University of Louvain (unfortunately prevented from attending owing to ill-health), and Prof. H. Laugier, of the Sorbonne. Of the three hundred and thirty participants representing twenty-six countries, eight were from Great Britain, and two of these—Miss G. Keir and Prof. G. P. Meredith—

presided over Congress sessions. The work of the Congress was at first carried out by seven groups, acting independently; then followed sessions of combinations of these groups, and, finally, all the group members came together to take part in symposia.

Group 1 of the Congress dealt with psychophysiological effects of cinematograph projection. Problems of three-dimensional and of colour representation, and of sound-recording, were considered, as well as physiological effects and a number of isolated perceptual phenomena; attention was also paid to the electro-encephalograph in relation to the film. Among those contributing were J. Faure, Y. Gallifret, C. E. M. Hansel, G. Heuyer and S. Lebovici. Prof. M. J. Colle, who presided, pointed out that some of the effects of the stimulation of films can be studied by normal physiological procedure, for they are the result of innate reactions. But another and more important category of effects are those resulting from an interpretation of the stimuli, and are partly dependent on acquired experience. These latter effects can best be investigated by the methods of the psychologist.

The psychological approach was employed by Group 2 in its study of the reactions of cinema-

audiences. Sociological problems of the cinema were examined by Group 3: the 'stereotypes' of the popular film, the intentional and unintentional propaganda of films, and the possibility of collecting material to provide a statistical basis for further sociological research. Group 4 dealt with the film as an instrument of teaching and research. Group 5 considered laws in relation to the cinema, the classifying of films according to their possible effects on viewers, and problems of censorship. Comparison of the film with other forms of expression was carried out by Group 6, and specifically with the medium of television by Group 7. The presidents of these six groups were M. Ponzio, M. J. Flaud, F. Buytendijk, G. Calo, B. Knipping and A. Marzi, and the chairmen at their various sessions were M. P. Fraisse, G. Friedmann, O. Klineberg, R. Lefranc, R. Bonnardel, R. Meili, E. Souriau, P. Francastel, H. Gratiot-Alphandery and H. Dieuzeide.

Not the least important filmological experiments reported during the Congress were those to do with modifications of the electro-encephalograph during cinematograph projection. These experiments have been carried out in France by J. Bert, G. Cohen-Séat, J. Faure, H. Gastaut, G. Heuyer, S. Lebovici, Mme. Rebeillard, Mlle. Daveau, and others, and some of the experiments have already been reported in an issue of the official journal of the Institut de Filmologie, *Revue internationale de Filmologie* (January-March, 1954). Sound films containing news-reel type items have been used, and into these films have been infrequently inserted strips of film which leave the screen suddenly lighted but blank for a short period. In one experiment a 'western' adventure film and a film of strong emotional content—showing delinquents—have been used. The subjects of the experiments have been various, and in one experiment have included animal subjects (dogs). The effect on the electro-encephalograph of the fluctuation of light intensity during projection, isolated from the effect of representation, has been examined; and breathing and other physiological effects have been recorded.

Present knowledge is insufficient to permit defined interpretations of the electro-encephalograph. There were factors apart from those to do with the film projection which may have caused some of the observed modulations, and the experimenters themselves do not claim to have arrived at sure conclusions. Nevertheless, these experiments represent pioneering work of a kind that may eventually lead to important advances in knowledge not only of the effects of film projection, but also in electro-encephalograph techniques and in the study of the brain. The film provides the research worker in this field with a convenient instrument. It may be that at length the film will provide the research worker in his laboratory with the means of presenting actual-life situations to the subjects of his experiments, and of studying the effects produced by such situations. First, however, it has to be established that reactions and thought processes similar to those that occur in ordinary life when not watching films can be brought about by film representation, and by what kind of film method. In relation to this, C. Denis Pegge maintained that there are two fundamentally different modes of mental reception from films, depending particularly on the use or non-use of speech; and he suggested that electro-encephalographic experiments might profitably be carried out to test this hypothesis.

A criticism made at the Congress of the electro-encephalographic experiments so far accomplished was that some of the observed effects might have resulted from forms of representation other than that of the film; also, the primary need of establishing a classification of spectator reactions was discussed.

The object of this Congress, as of all international congresses—to make known what is being done in different countries—was admirably fulfilled, and not the least of its benefits were the personal contacts it allowed. Much of the material of its communications must probably remain unco-ordinated; but some clarification as to the best way of sub-dividing the large subject of filmology may well follow the arranging of the material for publication. This considerable task is now being tackled by the Congress Committee, and should result in an important book. Thanks are due to those who organized the Congress, including the general and administrative secretaries, Mme. Bianka Zazzo and Mme. Chantal Loiseau; these latter were responsible for detailed arrangements which contributed to making this Congress not only valuable, but also most enjoyable. C. DENIS PEGGE

COMMONWEALTH FUND, NEW YORK

REPORT FOR THE YEAR 1953-54

THE thirty-sixth annual report of the Commonwealth Fund, which covers the year ended June 30, 1954*, lists more than forty appropriations made during 1953-54. Of the nineteen appropriations for medical education, thirteen were new grants. These grants fall into six general groups: those aimed at encouraging the better integration of professional and school or college education; those to assist the integrated teaching of the basic sciences to medical students in their first and second years; those to develop broader and more satisfactory relationships with patients by encouraging integrated teaching in the clinical years of the medical curriculum and better relations between the outpatient department, home care and the community; those in mental health, where the integration of psychiatry and clinical medicine is being encouraged, and the Fund is this year assisting a programme in preventive psychiatry, both teaching and research; those in nursing activities, chiefly to clarify the place of nursing in health activities and the training required for it; and those concerned with educational research and evaluation. The last, it is hoped, will lead to the development of improved techniques for assessing particular accomplishments or changes in students, better methods of selecting students for admission to medical schools, and the better definition and clarification of the objectives of the medical faculties themselves, as well as the provision of factual information as a basis both of administrative decisions and of the judgments that students are called upon to make about their future careers.

Five grants were made for experimental health services, the largest being a three-year grant to the Mary Imogene Bassett Hospital, Cooperstown, New York, towards the provision of a psychiatric service for a scattered, rural constituency. Another was

* Commonwealth Fund. Thirty-sixth Annual Report for the Year ending June 30, 1954. Pp. 12+42. (Commonwealth Fund, 1 East 75th Street, New York, 1954.)

towards the cost of a survey of the incidence and nature of long-term illnesses in a cross-section of the population of Baltimore, Maryland, and a third for a survey of the Rochester regional hospital programme. The other two were for a study of family experience with medical care in an urban population group and for planning and organizing programmes to improve medical care in selected Tennessee communities.

Of the thirteen grants for medical research, four were new, one of these being a survey of the work of the Child Research Council of the School of Medicine, University of Colorado. Much the largest grants in this group are those for studies of neural correlates of mental activity at the University of California School of Medicine and for the study of personality development at the Child Study Centre, Yale University; but large grants were also made for studies of resistance and susceptibility to experimental tuberculosis (Henry Phipps Institute, University of Pennsylvania School of Medicine), histochemical studies of the sub-microscopic organization of cells and extracellular substances (Department of Anatomy, University of Chicago), studies of cerebral function (New York University College of Medicine), a twin study of the hereditary and environmental factors in body build (Institute for the Study of Human Variation, Columbia University) and a study of the biological role of steroids (Worcester Foundation for Experimental Biology).

For advanced fellowships in medicine and allied fields, the Fund appropriated 100 million dollars, and the eighteen awards included eight for interdisciplinary study, five for special work relating to psychiatry, two for training in research and three for special experience and study. In the field of international education the major appropriation in 1953-54 was 685,890,000 dollars for a two-year budget for the established programme of the Commonwealth Fund fellowships for advanced study and travel in the United States. New awards under the programme, which also provides for the maintenance of Harkness House, London, included twenty general British fellowships, three Home, six Dominion and two Colonial Civil Service fellowships, and three journalism fellowships, while a two-year grant was made to the Institute of International Education and a one-year grant to the Salzburg Seminar in American Studies.

BLOOD COAGULATION AND THROMBOSIS

TWO main difficulties are immediately recognizable in research on blood coagulation. Only two or three of the dozen or so components of the blood-clotting system have been obtained in a state approaching purity, but the continued application of physico-chemical separations will probably improve this situation in the course of time. The second difficulty is the multiplicity of terms for components which can only be recognized by their effect on a clotting system, and thus it is very welcome news that an International Committee on the Nomenclature of Blood Clotting Factors is being formed to resolve the existing confusion. The editor and panel of contributors to the recent issue of the *British Medical Bulletin* (11, No. 1; 1955) are therefore to be congratulated on maintaining the high standard of

review associated with the journal in a field where there are exceptional difficulties.

In his introduction, R. G. Macfarlane points out that research in blood coagulation, which for more than a century has moved at a strictly academic tempo, has recently acquired a remarkable acceleration which he attributes partly to studies of haemorrhagic states (defective coagulation) and partly to the introduction of anticoagulant therapy for thrombosis (excessive coagulation). Tests of clotting efficiency, discussed by Dr. Rosemary Biggs, contribute both to the diagnosis of haemorrhagic states and to the control of anticoagulant therapy.

Recent advances in the understanding of haemophilia and allied disorders are presented by W. R. Pitney and J. V. Dacie. C. Hougie discusses another group of coagulation defects—those due to the development of anticoagulant factors in the blood. J. F. Ackroyd contributes two articles on the role of platelets in normal and pathological conditions, and J. B. Duguid discusses mural thrombosis in arteries.

Dr. Catherine Burt gives a very practical review of the clinical uses of anticoagulant drugs, discussing the heparin type of anticoagulant which acts directly on the blood-clotting system and also the coumarin type which acts by reducing the formation of blood-clotting factors. A table clearly sets out the doses, the times to obtain an effect and to return to normal afterwards, for the various coumarin-type drugs; the effect of the heparin type is obtained immediately after injection. Contra-indications and the results of therapy in various diseases are very thoroughly reviewed.

K. Bailey and F. R. Bettelheim discuss the conversion of soluble fibrinogen to insoluble fibrin by the enzyme thrombin. Here the picture of coagulation is clearer since fibrinogen and thrombin have recently been prepared in what appear to be pure forms. The discovery that the N-terminal group of fibrin differed from that of fibrinogen led to the isolation of a peptide split off from fibrinogen by the action of thrombin during clot formation. These facts, first discovered with bovine fibrinogen, are being confirmed for human fibrinogen by current research. R. A. Kekwick describes the large-scale separation of some of the clotting factors from human plasma. These factors are generally required in a very pure state for diagnosis and research; but for clinical application moderate purity suffices.

A careful analysis of the mode of action of coumarin drugs is presented by A. S. Douglas, who concludes that the serum of patients under therapy with these drugs is defective in its ability to form thromboplastin. R. B. Hunter and D. M. Shepherd contribute an interesting article on the chemistry of coumarin anticoagulant drugs in which they point out that it is still not possible to define the minimum structural characteristics that are required to confer anticoagulant powers on the molecule. The relationship between anticoagulant activity and the opposing vitamin K activity is discussed, and it is pointed out that competitive inhibition between coumarin anticoagulants and vitamin K exists only over a very limited dose-range. Vitamin K is a growth factor for certain micro-organisms, and a compound with anti-vitamin K activity in this respect may or may not be an anticoagulant.

A very comprehensive review of the chemistry and mode of action of heparin and related compounds is provided by K. W. Walton. After tracing the history of the purification of heparin through to present-day

views on its structure, the relation between structure and activity is discussed. The most recently discovered feature of heparin structure, the sulphated amino-group, may or may not turn out to be the key to the remarkably high anticoagulant activity of heparin as compared with other sulphated polysaccharides. Regarding the mode of action of heparin on the clotting system, it seems probable that heparin intervenes at more than one point. It certainly functions as an antithrombin and probably acts also against thromboplastin.

In a fine concluding article entitled "The Rubicon: Changing Views on the Relationship of Thrombosis and Blood Coagulation", Prof. A. H. T. Robb-Smith entertains us with a glimpse of a review of coagulation and thrombosis as it would have been written a century ago, perhaps in the "British Medical Almanack" of 1855. He manages to include much that is illuminating to-day and inspiring for the future, and some very sobering thoughts on the necessity of studying coagulation *in vivo* and not only in artificial systems. It appears that, if we could predict the onset of thrombosis, we could, by careful use of the drugs available to-day, avoid the disease altogether—a worthy objective for the scientific approach in medicine.

C. R. RICKETTS

UNIVERSITY OF LEEDS

At a meeting of the Court of the University of Leeds on December 15, 1954, the vice-chancellor, Sir Charles Morris, said that if the universities of Great Britain have succeeded in assimilating new studies which are most exigent of both human and material resources without destroying the essential nature of academic communities, this is largely due to the sympathy and wisdom of successive governments, which have seen it as their first task to enable each university to preserve its own special academic character and balance of interests. Only when this is secured has the government sought to encourage developments in particular fields, such as studies in oriental languages, social studies and higher technological education. In regard to the last-named, the Government's most urgent concern is to increase the number of graduates in technology available for industry and commerce after taking their first degree. So far as the University of Leeds is concerned, continued Sir Charles, the main limiting factor is accommodation; but some overcrowding has been accepted in the expectation that the necessary new buildings and extensions can be undertaken without great delay.

Sir Charles stated that it was expected to complete the chemistry and physics buildings of the University within the next few weeks, and a capital grant from the University Grants Committee will enable the work to begin without delay upon the first stage of the remaining extension; this extension is an essential part of the expansion of the technological departments, for which a new building has in addition been planned. Work on the first section of this latter building, to house the Department of Fuel Science, including now chemical engineering and metallurgy, was expected to start in about three months, with the aid of a large capital grant from the University Grants Committee. Accommodation available for the Medical School is also being increased, including new accommodation for the Departments of Biochemistry and of General Medicine; and in due

course, as part of the City development plan for the area north of the General Infirmary, it is hoped to plan and build a new Medical School. It is hoped to start the building of the first section of the new arts block early in 1957. This building, on the south side of University Road, is to have an impressive frontage looking south and is to balance the science block on the north side of the Parkinson Building.

Referring to the Government's known view that leaders of the future in technology should be educated in the university manner, side by side with the scientific workers and medical workers and those destined for the older professions, Sir Charles said that it is of the greatest importance that the universities should retain their traditional character and way of life. He thought that at Leeds, while not doing all that could be done, they were succeeding in this and were determined to do better still.

ANATOMY AND ANGIOSPERM CLASSIFICATION

IN an essay entitled "An Anatomist's Views on Angiosperm Classification" (*Kew Bull.*, No. 3, 427; 1954), C. R. Metcalfe has applied himself to the problem of how the taxonomist, confronted with the Angiosperms in all their abundance and diversity of species, can be helped in his aim to produce a natural classification, by making use of the results of laboratory investigations. Long experience has shown that the morphology of the reproductive structures, apparently less plastic than the other parts of the plant body, affords the most reliable criteria for purposes of classification. Nevertheless, the case is now forcefully presented that the micro-morphological characters of the vegetative organs can be used to advantage in taxonomic studies. Indeed, it has been shown that the conclusions based on the observation of such characters may show a large measure of agreement with those reached by the traditional methods.

In the body of the article, the author discusses critically, with citation of many interesting examples, the parallelisms in the evolution of the woody elements, for example, tracheids to vessels, scalariform end-wall plates to simple perforations, etc., the relationship of herbs to ligneous plants, and the *Durian* theory. He notes that if the diagnostic microscopic characters for most taxonomic groups above the level of families are surveyed, it becomes evident that orders and taxa of higher rank are heterogeneous. From this he concludes that orders are probably, with some exceptions, taxonomic conveniences, rather than assemblages of genetically related plants. By contrast, a study of the diagnostic microscopic characters of genera in individual families supports the view that most families appear to be homogeneous and therefore constitute natural groups. Where exceptions occur, this generally indicates a need for some taxonomic revision, or that a large family needs to be divided into distinct groups. The author concludes that taxonomy is likely to develop to the best advantage by the collaboration of the herbarium botanist with those who approach the subject by laboratory techniques. Moreover, the laboratory approach to taxonomy should lead to a closer integration of systematic with other branches of botany.

MARINE BIOLOGICAL RESEARCH

THE Marine Biological Association reports (*J. Mar. Biol. Assoc.*, 33, 3; 1954) the completion of the research vessel, *Sarsia*, and gives a photograph of this fine ship. Registered as ninety-five tons, she has two laboratories, a crew of sixteen, and accommodation for four scientists. An impressive account of work in progress is given in the report of the Council, and it is a pleasure to record an increase in membership of the Association of sixty-one, making a total of 770, and a satisfactory balance sheet.

In the present number, completing the thirty-third volume, there are sixteen papers, of which the most important are described below.

Dr. Vera Fretter and Prof. A. Graham, continuing their studies of small or aberrant gastropods, contribute an interesting account of the sand-burrowing *Acteon tornatilis*, a primitive British opisthobranch. This paper is illustrated by handsome drawings. In structure, *Acteon* forms a link between prosobranchs and opisthobranchs, and also exhibits more advanced and specialized characters.

Dr. Daphne Atkins has investigated the swimming habits of brachyuran megalopæ. Of the twenty-five species of crabs occurring at Plymouth, twenty-two swim in stream-lined fashion by tucking the chelipeds and first two pairs of pereopods beneath the body, the last two pairs being wrapped over the back, with the third pair looped around the eye-stalks. Three species fold all the legs beneath the body; these probably have a very short pelagic existence.

Dr. R. H. Millar contributes two papers on tunicates, one a description of a new genus and species, *Protostyela heterobranchia*, from west Scottish coasts. This is based on a single zooid, which is remarkable in possessing transverse stigmata. The second paper is an account of breeding and development in *Pelonaia corrugata*, an oviparous species, without pelagic larval stage.

Another interesting study from the Clyde area is a paper by Dr. R. B. Pike on the biology of *Spirontocaris lilljeborgii*. Using methods similar to those in his work on *Pandalus*, Dr. Pike proves that this species of *Spirontocaris* is dioecious, the males living one or two years, the females two or three years, and breeding for the first time in the second year. Egg-laying occurs in November and hatching in March. Sexual characters appear in the larvæ within six months of hatching.

Dr. Alexandrowicz adds to his histological series an account of the innervation of the heart of *Marino-*

gammarus marinus. He found a local system, situated dorsally, paired connexions with the central nervous system, and nerves supplying the valves. There is an ancillary system to the alary muscles and wall of the pericardium.

Dr. R. Phillips Dales and Dr. G. Y. Kennedy have investigated the orange, brown and green pigments of *Nereis diversicolor*, and the relation between their predominance and sexual reproduction. The green colour, due to biliverdin, is formed by the breakdown of the hæmoglobin of the blood. Dr. Kennedy and Dr. H. G. Vevers studied porphyrins in British marine invertebrates. Of forty-eight species, only seven, belonging to the phyla Annelida, Mollusca and Echinodermata, possessed any form of porphyrin, and none was found in coelenterates, Crustacea or tunicates.

Dr. L. R. Fisher, Dr. S. K. Kon and Dr. S. Y. Thompson have published their second paper on vitamin A and carotenoids in Crustacea, with special reference to seasonal variation. Present mainly in the eye in euphausiids, astaxanthin and vitamin A accumulate during the spring and autumn feeding periods, in association with diatom increases at those times. In brown shrimps and Norway lobsters there was no seasonal variation; but in the common lobster the highest concentration is in the spring. It is suggested that astaxanthin is a possible precursor of vitamin A. If this is so, euphausiids are unique among Crustacea in being able to produce vitamin A from the "ubiquitous crustacean pigment astaxanthin".

Dr. A. J. Matty discusses thyroid function in the dogfish, and the effects of injecting extracts of the gland into rats. His results are not conclusive; we wish him success in his visit to Barbados as Nuffield Fellow, in search of material from local fishes.

On the botanical side, Dr. Daphne Atkins contributes two papers on marine fungi belonging to the family Saprolegniaceae, affecting marine Crustacea and other invertebrates. The first species, *Leptolegnia marina*, attacks the body, eggs and embryos of *Pinnotheres pisum* and *P. veterum*, as well as two lamellibranchs, *Barnea candida* and *Cardium echinatum*. The second species, *Plectospora dubia*, attacks several kinds of Crustacea and is less pathogenic.

Two papers deal with oceanographical problems. Dr. J. N. Carruthers describes a penetrometer for use on submerged beaches, based on that used by road surveyors, and Mr. W. S. Preddy discusses the mixing of waters in the Thames estuary, with special reference to pollution.

EXPERIMENTAL EVIDENCE FOR THE COLLECTIVE NATURE OF THE CHARACTERISTIC ELECTRON-ENERGY LOSSES IN SOLIDS

By DR. D. GABOR and G. W. JULL

Department of Electrical Engineering, Imperial College of Science and Technology, London

IN a study extending over the past three years, we have been investigating the characteristic 'line' spectra of the energy losses of electrons in thin metal foils, first discovered by Ruthemann¹ and since confirmed by other workers². The apparatus used was a new electrostatic spectrograph, proposed by one of us³, in which the electrons describe helical trajectories. In the course of this work we were struck with the

erratic behaviour of the spectra, not reported by previous workers but evident enough from the wide discrepancies between their results. As in the case of most metals the variability might have been ascribed to chemical changes in the thin foils, we turned to gold, which at least gave clear evidence of a dependence of these spectra on structure, as distinct from chemical composition.

In one series of experiments we deposited gold films in two different ways on thin carbon films, prepared by the method of Bradley⁴. These proved the best substrates, owing to their low absorption and to the continuous character of their loss spectrum, shown in Fig. 1, curve *C*. Moreover, this spectrum is almost identical with that of the carbonaceous 'contamination' which covers every object in demountable vacuum devices under electron bombardment. One method (*A*) of depositing the gold film was by an uninterrupted process of evaporation. Fig. 1 shows the spectra of two continuous films, *A1* and *A2*, of 110 and 210 Å. thickness, respectively, produced by this method. The thickness was measured by simultaneously depositing a control film on a glass plate, at half the distance from the evaporator, measuring it optically by Tolansky's method, and dividing it by 4. The electron micrograph in Fig. 2 confirms the continuous character of layers produced by this method. In method *B*, the deposition was carried out in steps of about 30 Å. each. The evaporator operated in the same vacuum as the spectrograph, and the specimen could be transferred instantly into the spectrograph, without breaking the vacuum. Every time a layer of about 30 Å. was deposited, it was measured, which meant exposing it for about 20 min. to the electron beam. This was sufficient to deposit on it at least 10 Å. of contamination; thus the specimen consisted ultimately of alternate layers of gold and of carbonaceous matter. Fig. 3 is an electron micrograph of such a stratified specimen of 170 Å. aggregate gold thickness. It appears strongly granulated, presumably through the lateral rearrangement of the gold atoms under the heating by the electron beam. The granules, with the exception of the smallest ones, are certainly not

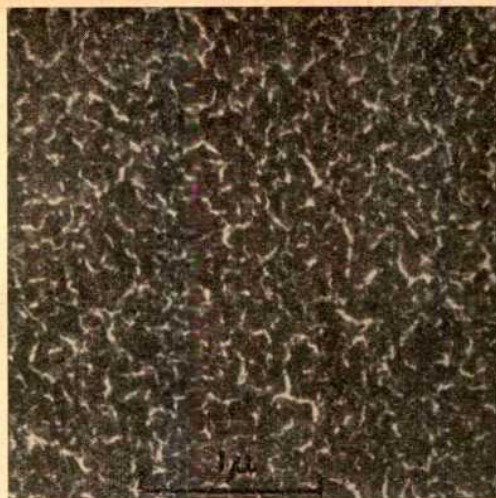


Fig. 2. Electron micrograph of gold foil of the 'continuous type', produced by uninterrupted deposition

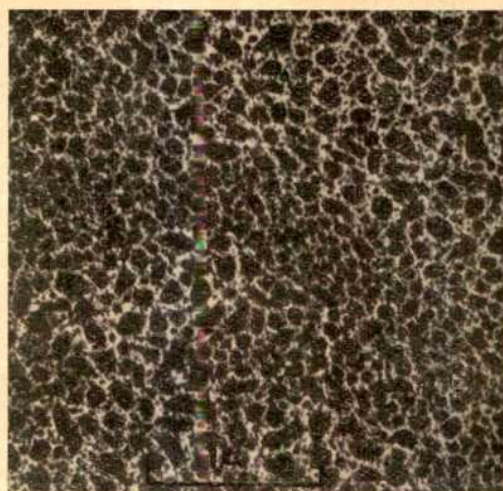


Fig. 3. Electron micrograph of the stratified type, 170 Å. aggregate gold thickness, built up of six layers of gold, alternating with carbonaceous layers of 'contamination'

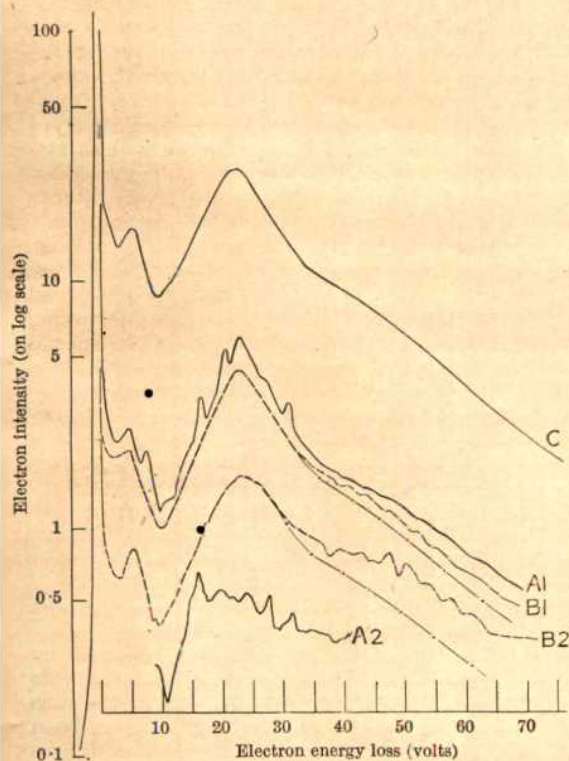


Fig. 1. Energy loss spectra of 10.5 keV. electrons in gold foils. *C*, carbon substrate, about 100 Å. thick. *A1*, Continuous gold foil, 110 Å. *A2*, Continuous gold film, 210 Å. *B1*, Stratified film, 120 Å. aggregate gold thickness. *B2*, stratified, 170 Å.

globular in shape, but may be visualized as flat flakes, with a layer structure.

The curves *A1*, *A2* and *B1*, *B2* reveal clearly the presence of a strong group of characteristic losses between 8 and 32 eV. in the continuous gold foils, and their total absence in the stratified films. On the other hand, another group of losses between 40 and 65 eV. comes out with about equal intensity in the *A*- and *B*-foils. (Curve *A2* is not continued into this range; but the presence of this group in continuous films was confirmed in other experiments.) Thus the second group may be due to the interaction of the beam electrons with single core-electrons, but not the first. One must expect interaction with single electrons, especially with those in the inner shells, to be independent of the structure and to depend only on the aggregate gold thickness. The curves *B1* and *B2* indicate a process which does not start below a certain critical thickness, and this cannot be explained by single collisions.

The question arises whether the theory of collective interaction, first proposed by Bohm and Pines⁵, might be able to account for this phenomenon. The answer is yes, with certain qualifications.

'Collective' losses are due to the transfer of one quantum to the vibrational modes of the electron gas in the metal. One of us (D. G., unpublished work) has investigated a model in which the metal is replaced by a sheet of an electron gas, with vibrational modes distributed according to the dispersion law of Bohm and Gross, each with the zero-point energy $\frac{1}{2}\hbar\omega$, with random phases. The incident electron wave interacts with these oscillators during a time τ . This must not be identified with the transit time of the electrons through the metal layer; for with 10-keV. electrons and characteristic losses of the order of 15 eV., the transit angle $\omega\tau$ would be only about 2π for the thickest foils investigated, and one could not explain the sharp lines of a width of at most 1-2 eV. which have been observed, even in much thinner foils. The interaction time must be interpreted as the time in which the wave train, defined by the uncertainty of thermal emission velocities, passes through the foil. This gives resonances of the required sharpness, since this time corresponds to a foil thickness of about 1500 Å. for 10-keV. electrons emitted by a tungsten cathode, and to transit angles of the order $10 \times 2\pi$.

As the interaction time is practically independent of the thickness of the foil, an effect such as we have observed can be explained in two ways only. One is, that foils of type B were in fact so finely granulated transversally to the thickness that the beam was strongly diffracted, and only a fraction of it passed the fine aperture of the spectrometer. This, however, is directly contradicted by electron diffraction diagrams, which show unmistakably that foils of type A are in fact more finely granulated transversally than foils of type B, which seem to have

undergone a crystallization process in two dimensions.

The other explanation, and the only one which we now believe fits the facts, is that the sheets of type B have less vibrational modes per unit volume than continuous foils of type A. This is readily understood on the basis of the theory of collective oscillations of plasmas, since the longest wave which can exist in a sheet of thickness a has the wave-length $2a$. But theory shows that this 'long-wave cut-off' can become effective with a of the order of 30 Å. only if we assume that the 'short-wave cut-off' due to damping is at much longer wave-lengths than hitherto assumed; not at 1-2 Å., as in the theory of Pines and Bohm, but perhaps at 50-60 Å. Moreover, the multiplicity of the characteristic loss spectrum forces us to believe that the spectrum mode of the electron gas in most metals forms not one wide band, but a series of narrow bands, each of a fraction of a volt only.

This investigation was carried out in the Electronics Laboratory of the Department of Electrical Engineering, Imperial College of Science and Technology. One of us (G. W. J.) thanks the Athlone Fellowship Committee, the Canadian Research Council and the Canadian Defence Research Board for enabling him to carry out this work. We thank Messrs. M. E. Haine and A. W. Agar, of the Research Laboratory, Associated Electrical Industries, Ltd., Aldermaston, for taking electron micrographs and diffraction diagrams of our specimens. [Feb. 7

¹ Ruthemann, G., *Naturwiss.*, **29**, 648 (1941).

² Mollenstedt, G., *Optik*, **9**, 473 (1952). Marton, L., and Leder, L. B., *Phys. Rev.*, **94**, 203 (1954).

³ Gabor, D., *Proc. Phys. Soc.*, **64**, B, 244 (1951).

⁴ Bradley, D. E., *Brit. J. App. Phys.*, **5**, 65 (1954).

⁵ Bohm, D., and Pines, D., *Phys. Rev.*, **92**, 609 (1953).

CHEMICAL EFFECTS OF X-RAYS UPON AQUEOUS SOLUTIONS OF CORTISONE AND DEOXYCORTICOSTERONE

By R. ALLINSON, DR. B. COLEBY and DR. J. WEISS

King's College (University of Durham), Newcastle upon Tyne 1

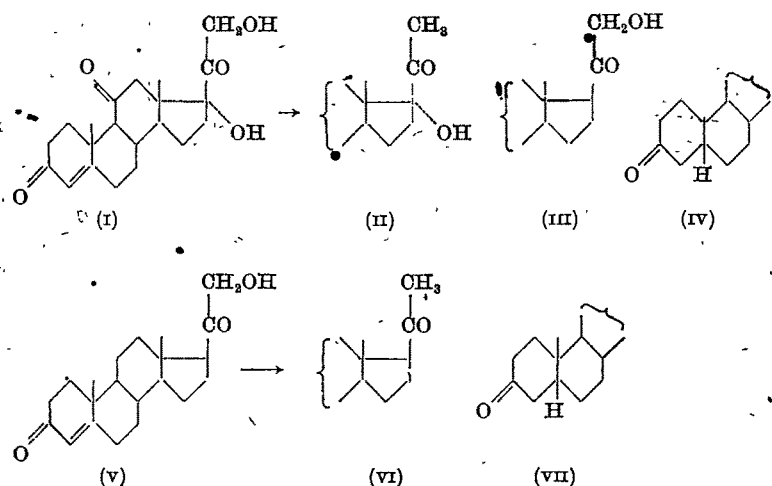
THE effects of X-rays (200 kV.) upon some steroids in solution have been reported earlier by Keller and Weiss¹, who found that the chemical effects were mainly oxidative in nature: for example, hydroxylation of double bonds or other activated positions, oxidation of secondary alcohols to ketones. Coleby, Keller and Weiss² observed similar effects when steroids dissolved in certain organic solvents were irradiated. Barron³ measured the decrease in ultra-violet absorption on irradiating aqueous solutions of cortisone acetate and hydroxycorticosterone in the presence and absence of oxygen. We now wish to report the identification of some products formed from cortisone and deoxycorticosterone when their aqueous solutions are irradiated with X-rays (200 kV.)⁴.

Identification is based upon comparison with authentic materials in as many of the following tests as could be applied: chromatographic properties of the products and of their acetates⁵; ultra-violet absorption spectra; reaction with tetrazolium salts;

the Porter-Silber reaction for 17α : 21-dihydroxy-20-oxo-steroids; absorption spectra in concentrated sulphuric acid; oxidation with chromic oxide or sodium bismuthate, followed by chromatographic resolution of the products; infra-red absorption spectra.

By these methods we have been able to show the occurrence of the following processes when *de-aerated* solutions are irradiated: dehydroxylation in the 17α - or in the 21-position of cortisone, and correspondingly in the 21-position of deoxycorticosterone; hydrogenation of the double bond of cortisone and deoxycorticosterone. Thus, cortisone (I) gave 21-deoxycortisone (II), 11-dehydrocorticosterone (III) and dihydrocortisone (IV), while deoxycorticosterone (V) gave progesterone (VI) and 21-hydroxypregnane-3: 20-dione (VII).

Furthermore, we have evidence to indicate that the following processes also occur with cortisone solutions: (i) complete reduction of the Δ^4 ,3-oxo system to give 3β -hydroxy derivatives, (ii) reduction



of the 3-oxo group (before reduction of the Δ^4 -double bond occurs); (iii) addition of one hydroxyl group and one hydrogen atom to the double bond, (iv) elimination of a carbon atom from ring A to give *A-nor*-3-oxo-steroids (this last reaction appears to be the most important single reaction occurring during radiolysis). A small amount of adrenosterone, formed by elimination of the side-chain of cortisone, was also isolated.

The overall reaction of corticosteroids during radiolysis may be studied by the decrease in absorption due to the Δ^4 -3-oxo group and by the decrease in ability to react with tetrazolium salts. The attack upon the side-chain is comparatively slight, and it can be accounted for quantitatively in terms of the products mentioned above. The attack upon the Δ^4 -3-oxo system is much more marked, and its extent decreases rapidly with increasing dose (see Fig. 1 for cortisone solutions; similar results were obtained with deoxycorticosterone solutions). This indicates that cortisone is strongly 'protected' by its reaction products, that is, these react with the radicals produced by ionizing radiations more readily than does cortisone.

It is generally agreed that the absorption of hard X-rays by water gives rise to hydrogen atoms and hydroxyl radicals ($\text{H}_2\text{O} \xrightarrow{\text{radiation}} \text{H} + \text{OH}$) and, to a much smaller extent, molecular hydrogen and hydro-

gen peroxide⁶. Hydrogen and hydrogen peroxide in the concentrations formed during radiolysis were found to be without action upon corticosteroids, so that the observed reactions may be ascribed to hydrogen atoms and hydroxyl radicals. The products identified above are, presumably, the result of reaction with hydrogen atoms.

When molecular oxygen is present in solution, the hydrogen atoms are readily removed by the reaction: $\text{H} + \text{O}_2 \rightarrow \text{HO}_2$. The irradiation of cortisone solutions saturated with oxygen was found to give products differing markedly from those obtained in the absence of oxygen. Again, a small amount of adrenosterone was obtained, and some of the suspected 17α :21-

dihydroxy-*A-nor*pregnane-3:11-20-trione; but the remainder of the products isolated could not be identified with those obtained from deaerated solutions. The curve obtained for the destruction of the Δ^4 -3-oxo system on irradiation of oxygenated solutions (see Fig. 1) varies linearly with increasing dose, showing that cortisone is not 'protected' by its reaction products in the presence of oxygen; this is true even when a large proportion of the cortisone initially present has been destroyed. In general, it would be expected that attack of the steroid molecule by a free radical would produce another radical which would readily add on molecular oxygen, leading eventually to a hydroperoxide type of molecule⁷. It was found that irradiated oxygenated solutions did give reactions indicating the presence of substantial quantities of hydroperoxides, but these substances did not survive the process of chromatography; presumably the numerous substances detected chromatographically represent the decomposition products of these hydroperoxides.

The isolation of the compounds reported above is interesting because of the complete contrast with the mainly oxidative reactions previously observed on irradiation of steroid solutions^{1,2}.

While it has long been recognized that irradiation of aqueous solutions can cause reductions, the dehydroxylation and hydrogenation of double bonds of organic compounds have not previously been reported. Some of these reactions are also of interest in that similar products have been isolated in the metabolism of corticosteroids⁸.

Work is in progress to complete the isolation and identification of other products formed in the radiolysis. We gratefully acknowledge the financial assistance of the Medical Research Council and of the Northern Council of the British Empire Cancer Campaign in support of this work. Infra-red spectra were measured with the kind co-operation of Dr. A. E. Kellie, of the Courtauld Institute of Biochemistry. [Feb. 1]

¹ Keller, M., and Weiss, J., *J. Chem. Soc.*, 2709 (1950); 25, 1247 (1951).

² Coleby, B., Keller, M., and Weiss, J., *J. Chem. Soc.*, 60 (1954).

³ Barron, E. S. G., *Radiation Research*, 1, 109 (1953).

⁴ For experimental arrangements of Farmer, F. T., Stelm, G., and Weiss, J., *J. Chem. Soc.*, 3241 (1949).

⁵ Bush, I. E., *Biochem. J.*, 50, 390 (1952).

⁶ Weiss, J., *Ann. Rev. Phys. Chem.*, 4, 143 (1953).

⁷ cf., for example, Bollani, J. L., *Quart. Rev. Chem. Soc.*, 3, 1 (1949).

⁸ Dorfman, B. L., and Ungar, F., "Metabolism of Steroid Hormones" (Burgess Pub. Co., Minneapolis, 1953).

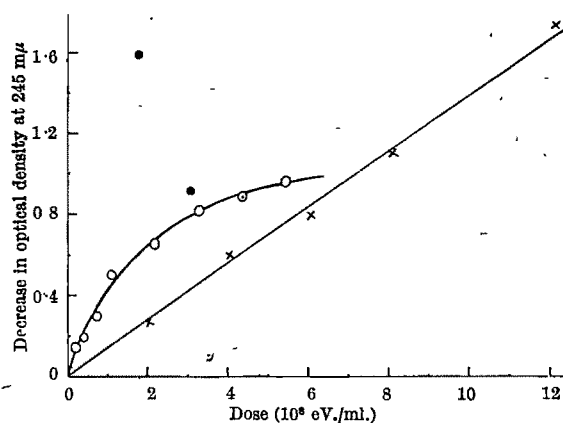


Fig. 1. Decrease in absorption at 245 mμ (0.5 cm. cells) against radiation energy absorbed (in 10⁵ eV. per ml.) for aqueous cortisone solutions. —○—○—, deaerated solutions; —x—x—, oxygenated solutions

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Antibiotic of Bacterial Origin

AN antibiotic with therapeutic activity has been obtained from a spore-bearing bacillus of the *B. pumilis* group. The organism was isolated from soil collected in East Africa by Dr. Philip Spensley. The antibiotic is obtained in good yield from a medium containing inorganic salts, ammonium citrate, glucose and meat extract, both in shallow-layer and in aerated deep cultures.

The culture is acidified to pH 2.5, and ammonium sulphate added to 20 per cent concentration. The precipitate is collected by centrifugation, extracted with ethanol and the extract evaporated to dryness. The solid residue is washed with ether and with water, and the insoluble portion dissolved in ethanol and passed through a column of alumina. The active substance is obtained by evaporating the eluate to dryness and is crystallized from a mixture of acetic acid and ethyl acetate.

The antibiotic is a white crystalline solid sparingly soluble in water and turning yellow on exposure to light. It discolours at 232°, sinters at 238° and appears to melt at 252°. It has the composition C = 48.9, H = 4.7, N = 13.7, S = 16.0, O = 16.7 per cent, corresponding to a minimal formula of $C_8H_6N_2O_2S$. It does not give a ninhydrin test even after hydrolysis with hydrochloric acid, and so is unusual in being a non-peptide antibiotic from a bacterial source.

In nutrient broth it inhibits the growth of *Staphylococcus aureus* at a dilution of 1 in 20 million, of *Pasteurella muriseptica* at 1 in 50 million, of *Streptococcus haemolyticus* group A at 1 in 18 million and of an avirulent *Mycobacterium tuberculosis* at 1 in 200,000. It is not active against *Bact. coli*, *Shigella flexnerii* or *Candida albicans* at 1 in 25,000. It is just as active in whole blood as in broth against *S. haemolyticus*.

The substance is non-toxic. Mice survived the highest doses given, namely, 1 gm. per kgm. subcutaneously and 0.5 gm. per kgm. subcutaneously repeated daily. It is effective against haemolytic streptococcal infection in mice. A single 2.5 mgm. intraperitoneal dose given up to five hours after the infection gave 100 per cent protection against an intraperitoneal infection of 1,000 lethal doses. Repeated 5 mgm. intraperitoneal doses of antibiotic saved all mice receiving a subcutaneous infection of 10 lethal doses. Daily 5 mgm. subcutaneous doses saved only 50 per cent of mice receiving 1,000 lethal doses of streptococci intraperitoneally. It was inactive by the oral route. The reduced effectiveness by the subcutaneous route is probably due to very slow absorption caused by its low solubility.

Larger quantities of antibiotic are being prepared and a further investigation of its chemical nature and therapeutic properties will be made. I wish to thank Mr. J. E. Lee for technical assistance.

A. T. FULLER

National Institute for Medical Research,

London, N.W.7.

Feb. 24.

Quantitative Determination of Phosphatase Activity in Chick Embryo Duodenum cultured in Fluid Media with and without Hydrocortisone

DIFFERENTIATION and phosphatase accumulation in the intestinal epithelium of the sixteen-day chick embryo cultured *in vitro* were accelerated by the addition of hydrocortisone to the nutritive medium¹. When an attempt was made to culture relatively large pieces of duodenum, in order to determine phosphatase content quantitatively, it was found that the best survival and differentiation were obtained in those specimens that liquefied the plasma clot on which they were placed; such free-floating pieces maintained a normal surface configuration without any tendency to form the elaborate outgrowths that develop when a solid substrate is present. This observation has now led to the finding that as much as 25 mgm. of embryonic duodenum may be successfully cultured in 2 ml. of fluid, in a 25-ml. Erlenmeyer flask.

In the principal experiments described in this communication, the duodenal loops of sixteen-day chick embryos were excised under sterile conditions, placed in Earle's saline solution, and split lengthwise, each half being used for a single culture. Each half was cut into eight to fifteen fragments weighing 1-2 mgm. apiece, and these were placed in the medium, which was either Earle's saline or the synthetic medium No. 199 of Morgan *et al.*²; in some cases 1 µgm. of hydrocortisone had been added to the medium. The culture flasks were closed with tight-fitting rubber caps, and kept at 38° C. At two-day intervals, the fragments were removed from the flasks, washed in Earle's solution, and replaced in fresh medium. Cultures were maintained up to five days, by which time the donor embryos would have hatched.

Within a few hours after being cut, the fragments healed into rounded masses with the musculature inside and the villi covering most of the surface. In all test media the villi developed normally during the first forty-eight hours; but during the following day the villi in the saline alone shortened and disappeared, so that the fragments frequently came to be covered by a smooth layer of cuboidal epithelium. In the synthetic medium, similar changes occurred, though more slowly. In both media, however, when 1 µgm. of hydrocortisone was added, long villi persisted to the end of the experiments; but the epithelial cells covering these villi, though columnar, did not differentiate so far as they would have *in vivo*, seeming rather to be arrested at the nineteen-day condition.

At daily intervals some cultures were used for weight, nitrogen and phosphatase determination, or for fixation. Weighing was done on a torsion balance of 30 mgm. capacity; in this operation all fragments from one half-duodenal loop were picked up with fine forceps and placed on an aluminium weighing pan from which excess fluid was blotted up on tiny filter-paper sponges. Although it was not possible to show how the weight of any individual culture changed, comparison of the weights of terminal cultures with weights of equal numbers of uncultured sixteen-day fragments indicated that there is a steady decrease in weight, the greatest loss occurring in the first twenty-four hours. By twenty-one days the cultured fragments had apparently lost about half their initial weight. Both gross and histological

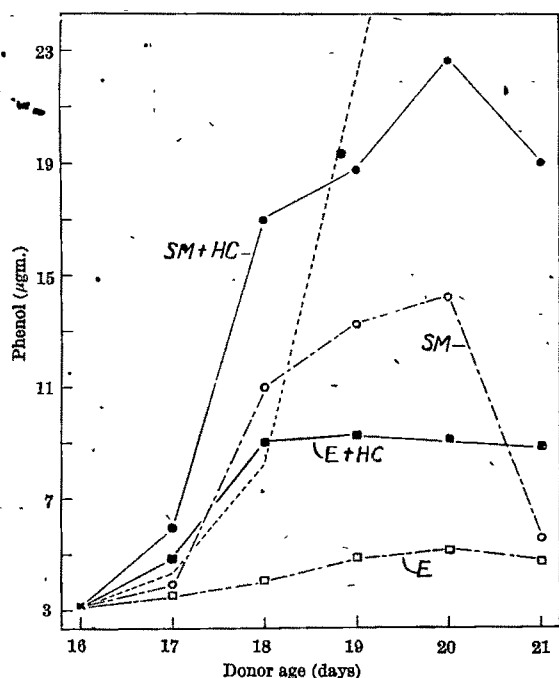


Fig. 1. Accumulation of phosphatase in fragments of sixteen-day chick embryo duodenum cultured in fluid. Enzyme activity is expressed as micrograms of phenol liberated by 1 mgm. of fresh tissue in 30 min. SM = synthetic medium; E = Earle's saline; HC = hydrocortisone; each point is the average value of 8-14 cultures; the dotted line represents the increase of phosphatase *in vivo*.

appearance suggested that this change was not due to the loss of water.

After weighing, the fragments were ground in an all-glass homogenizer of 5 ml. total capacity. The homogenate was diluted to 3-5 mgm./ml., and an aliquot used for determination of total nitrogen. In contrast to the steady increase in duodenal nitrogen *in vivo* between sixteen and twenty-one days^{3,4}, the nitrogen concentration *in vitro*, under all test conditions, showed no detectable change, remaining at about 1.2 per cent of fresh weight.

Phosphatase activity was determined on phenylphosphate, quantities being scaled down where necessary to one-quarter of those usually employed³. In saline medium alone, it appears that phosphatase rises to a negligible extent (Fig. 1); but if hydrocortisone is added, the enzyme increases at the normal rate to the eighteen-day level, thereafter remaining unchanged. In synthetic medium alone the rate of increase is even faster, and in synthetic medium plus hydrocortisone the rate is twice as fast as *in vivo*. In both cases, however, the rate slackens after the donor age of eighteen days, and finally there is an absolute loss of enzyme, the loss being most severe in the cultures without hormone, in which the villi have usually disappeared by the twenty-first day. This slackening of rate and subsequent decline of enzyme content could not be prevented either by filling the culture vessels with 95 per cent oxygen/5 per cent carbon dioxide, or by removing waste carbon dioxide by means of a small quantity of 10 per cent potassium hydroxide placed in a centre well in the culture vessel.

Duodenal fragments from embryos of twelve, fourteen and seventeen days have also been raised in culture. All these respond to synthetic medium and

to hydrocortisone in much the same way as the sixteen-day tissue, except that at the earlier stages the response to the hormone is somewhat delayed, as it is *in vivo*⁴. Eighteen-day tissue did not survive for more than twenty-four hours under the conditions employed.

Although the duodenal fragments do not increase in mass in the fluid cultures, it is evident from the patterns of phosphatase accumulation that they do utilize some of the substances of small molecular weight contained in the synthetic medium. Whether it is the amino-acids that are utilized, or other materials, is not yet known. That some essential factors are still lacking, however, is shown by the failure of differentiation and phosphatase accumulation to be carried beyond the normal nineteen-day level. The missing factors are not found in fowl serum or ten-day embryo extract, for the previously mentioned cultures that were raised on plasma and extract showed the same nineteen-day arrest of phosphatase increase, and subsequent decline, as did those in synthetic medium. Possibly the very great differentiative changes that occur in the intact duodenum after nineteen days, but have not yet been duplicated in culture, reflect the synergistic action of other hormones with adrenocorticoids.

This investigation was supported by grant G-3937 of the National Institutes of Health, U.S. Public Health Service.

FLORENCE MOOG
MORTON H. KIRSCH

Department of Zoology,
Washington University,
St. Louis, Missouri,
and
Molteno Institute,
Cambridge.
March 4.

¹ Moog, F., and Nehari, H., *Science*, **119**, 809 (1954).

² Morgan, J. F., Morton, H. J., and Parker, R. C., *Proc. Soc. Exp. Biol. Med.*, **73**, 1 (1950).

³ Moog, F., *J. Exp. Zool.*, **115**, 109 (1950).

⁴ Moog, F., and Richardson, D., *J. Exp. Zool.* (in the press).

Formation and Radiosensitivity of Myoglobin

HÆMOGLOBIN is laid down in the maturing erythropoietic marrow cells. Exposure to ionizing radiation depresses the formation of new erythropoietic marrow cells and may destroy any such cells already present. Anæmia resulting from this interference manifests itself after the lapse of some days in a reduced erythrocyte count and reduced hæmoglobin content of the circulation. It becomes visible after the lapse of a few hours through a reduced incorporation of administered radio-iron into the circulating red corpuscles¹⁻³.

To investigate if, in addition to interference with the milieu in which the hæmoglobin is laid down, irradiation interferes with hæmin formation *per se*, we have investigated the effect of exposure to radiation on the formation of such hæmins as, for example, cytochrome *b* of the liver, which are not formed in connexion with mitotic processes. Doses up to 1,300 r. were found not to reduce the incorporation of iron-59 into cytochrome *b*. We found⁴, however, that incorporation into myoglobin of muscles

Table 1. EFFECT OF EXPOSURE TO 500 R. OF X-RAYS ON THE INCORPORATION OF IRON-59 INTO HÆMOGLOBIN AND MYOGLOBIN

	Time in hr.		Specific activity					
	Between exposure and injection	Between injection and termination of life	Hæmoglobin			Myoglobin		
			Control	Irradiated	Irradiated Control	Control	Irradiated	Irradiated Control
Guinea pigs	6	18	100 100 100	20 22 28	0.20 0.22 0.28	42 22 18	18 10 7	0.43 0.45 0.39
Rats	6 6 23 23	66 66 46 46	100 100 100 100	49.0 49.3 8.9 5.1	0.49 0.49 0.09 0.05	19.8 18.4 16.1 15.0	12.5 10.7 2.67 1.52	0.83 0.58 0.16 0.10

49 per cent of injected iron-59 incorporated in the course of 66 hr. into hæmoglobin

extracted from eighty guinea pigs and thirty rats injected with 1–5 μ gm. of iron-59 of an activity of 1–4 μ c. administered intraperitoneally as citrate was very markedly, and to a similar extent, depressed on incorporation into hæmoglobin.

Not only is the effect of irradiation on myoglobin formation very similar to that on hæmoglobin formation, but also it fully manifests itself only after a time interval of about a day, as does its effect on hæmoglobin formation. It was observed by Hennessy and Huff¹ and others that maximal depression of incorporation of radio-iron into the red corpuscles is observed only about one day after exposure of rats to a dose of a few hundred röntgens. The following explanation is suggested for this time-lag of the radiation effect.

The laying down of hæmoglobin in erythropoietic cells takes place, as shown by Thorell², more pronouncedly in the later phase of maturation of erythroblasts than in earlier ones. In autoradiographic studies on iron-59 turnover by erythroid cells in rat bone marrow, Austoni³ found the percentage of labelled cells in anæmic rats 3 hr. after administration of iron-59 to be for pro-erythroblast cells 37, the corresponding figures for basophilic, polychromatic and orthochromatic erythroblasts being 82, 94 and 90, and for the mature red cells 7. So long as viable normaloblasts with an incomplete hæmoglobin content are present in the bone marrow, the laying down of iron-59 into hæmoglobin will go on in the exposed organism. Only after these cells have left the bone marrow, which takes about a day, will the full effect of exposure to radiation manifest itself in much reduced incorporation figures of iron-59 into hæmoglobin of the circulation. Mitosis and hæmoglobin synthesis are not necessarily correlated, though, of course, blockage of mitosis and degeneration of cells will inevitably lead to failure of formation of further hæmoglobin.

In Table 1 is seen the effect of exposure to 500 r. of X-rays on incorporation of iron-59 into myoglobin prepared according to Theorell and Åkeson⁴ and also into hæmoglobin.

A mitotic figure of 3 found in the bone marrow of the rat⁵, amounting to about 1 per cent of the body-weight, suffices to keep up the normal hæmoglobin level, that is, to replace the erythrocytes which have terminated their life-cycle. As the myoglobin content of the rat⁶ amounts to 1/32 only of that of its hæmoglobin content, its muscles are 46 per cent of body-weight; and as we find by comparing the specific activity of myoglobin and hæmoglobin iron that the life-time of the myoglobin is about four times longer¹⁰ than that of hæmoglobin, a nuclear division figure (muscle nuclei are said to divide

mainly in an amitotic way) of $\frac{1}{32 \times 4 \times 46} = \frac{1}{5,888}$ only of that observed in the bone marrow should suffice to keep up the normal myoglobin level. Measurement of such a low nuclear division figure by the usual histological methods may encounter very great difficulties. Text-books of histology do not contain any account of the building up of myoglobin. The above consideration strongly suggests that this compound is laid down in the course of maturation of cells of the muscle tissue in a manner similar to that in which hæmoglobin is laid down during the maturation of erythropoietic cells of the bone marrow.

R. BONNICHSEN
G. HEVESY
Å. ÅKESON

Nobel Institute of Biochemistry,
Institute of Organic Chemistry and Biochemistry,
University of Stockholm.
Feb. 15.

¹ Hennessy, T. J., and Huff, R. L., *Proc. Soc. Exp. Biol. Med.*, **73**, 436 (1950).

² Belcher, E. H., Gilbert, I. G. F., and Lamerton, L. F., *Brit. J. Radiol.*, **27**, 387 (1954).

³ Hevesy, G., and Bonnichsen, R., "Biochemistry of Nitrogen", 295 (Helsinki, 1955).

⁴ Bonnichsen, R., and Hevesy, G., *Acta Chem. Scand.* (in the press)

⁵ Theorell, H., and Åkeson, Å., "Biochemistry of Nitrogen", 303 (Helsinki, 1955).

⁶ Thorell, B., *Acta Med. Scand.*, **129**, Supp. 200 (1947).

⁷ Austoni, M. E., *Soc. Exp. Biol. Med.*, **85**, 48 (1954).

⁸ Grant, W. C., *Proc. Soc. Exp. Biol. Med.*, **77**, 534 (1951).

⁹ Crandall, N. W., and Drabkin, D. L., *J. Chem. Biol.*, **168**, 649 (1946).

¹⁰ A similar figure follows from the studies of incorporation of iron-59 into myoglobin by Theorell, H., Bézák, M., Bonnichsen, R., Paul, K. G., and Åkeson, Å., *Acta Chem. Scand.*, **5**, 445 (1951), and by Helwig, H. L., and Greenberg, D. M., *J. Biol. Chem.*, **198**, 703 (1952).

Modulating Action of the Thyroid on Oestrogen-induced Pituitary Tumours in Rats

THE capacity of oestrogen to induce tumours of the pituitary gland in the intact rat is well known, although the mechanism whereby these tumours are consistently produced remains unsolved. In the present investigation, it is shown that the thyroid gland, at least, plays an important part in modifying the incidence of hyperplasia and tumour formation of the pituitary gland induced by prolonged treatment with oestrogen.

A total of 184 adult albino rats of the Wistar strain were used for the various experiments set out in Table 1. Oestrogen was made available to 173 of these rats in the form of single pellets of oestradiol benzoate, weighing 6–8 mgm. and implanted sub-

Table 1

	A			B			C			D			E			F		
	Oestradiol benzoate only			Oestradiol benzoate + thyroxin			Oestradiol benzoate + thiouracil			Oestradiol benzoate + thyroidectomy			Oestradiol benzoate + dietary restriction			Thiourea only		
Duration of experiment (days)	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats	Range of pituitary weights (mgm.)	Average weight of pituitary (mgm.)	No. of rats
1-50	15-45	30	8	15-50	29	7	20	20	1									
51-100	34-94	53	4	71-302	138	9	8-46	21.3	13				9-13	9	3	8-10	9	7
101-150	28-405	217	8	179-273	226	2	19-34	24.8	7	29	29*	1	8-41	22	3			
151-200	46-434	275	24	173-602	398	9	23-73	42.1	7	19, 19	19	2	31, 40	36	3			
201-250	164-442	311	28				21-68	36.5	8				11-20	16	3	9-17	14	4
251-300	145-359	281	16							55	55*	1						
301-350	214-364	266	5															
Total No. of rats			93			27			36			4			13			11

* Thyroid fragment present.

cutaneously. Thiourea and thiouracil were fed at a 0.5 per cent level in the stock ration¹. To avoid acute pulmonary oedema known to occur after the inclusion of 0.5 per cent thiourea in the diet, the drug was fed in graded amounts, starting at a level of 0.01 per cent and gradually increasing to 0.5 per cent. Thyroxin was injected subcutaneously three times a week in doses of 20 μ gm. A group of thirteen rats, implanted with pellets of oestradiol benzoate, were fed half the amount of the stock ration consumed by rats also bearing a pellet of oestradiol benzoate. The rats on the reduced ration lost weight for the first month, and then maintained their weight until a few weeks before they died or were killed when moribund.

Oestradiol benzoate promotes a steady enlargement of the pituitary gland in normal adult rats (Table 1, A). The glands may become so large that the hypothalamus and related parts of the brain may be compressed. Although pituitary enlargement can be detected in some rats by the 50th day, the gland may have increased forty-fold in weight between the 100th and 150th day.

The administration of thyroxin accelerates the development of pituitary tumours and leads to premature death of the rats (Table 1, B). The pituitary glands exceeded 400 mgm. in weight in five of the group of nine rats treated with thyroxin and dying between the 150th and 200th day, whereas in the group not receiving thyroxin only two pituitaries exceeded 400 mgm. at a corresponding stage of the experiment (Table 1, A).

In striking contrast, the pituitary gland showed only mild hyperplasia in rats bearing an oestrogen pellet but fed thiourea or thiouracil (Table 1, C). The heaviest gland in this group of rats did not exceed 73 mgm. Although only two of the six thyroidectomized rats treated with oestrogen survived beyond the 100th day, there was sufficient evidence that thyroidectomy also prevented the enlargement of the pituitary gland (Table 1, D). Even partial thyroidectomy seemed to counteract the effect of oestrogen.

Dietary restriction inhibited pituitary enlargement as effectively as did the feeding of antithyroid drugs (Table 1, E).

On the basis of these observations, it can be concluded that depression of thyroid function, following

either the administration of thiourea or thiouracil, or a reduction in food consumption, inhibits pituitary hyperplasia and tumour formation in oestrogen-treated rats, whereas thyroxin has the reverse effect. It is suggested that any set of circumstances which leads to a depression of metabolism will modify the action of oestrogen on the pituitary gland. It is furthermore evident that a functionally active thyroid gland is indispensable for the development of pituitary tumours.

JOSEPH GILLMAN
CHRISTINE GILBERT

Departments of Physiology and Anatomy and
Joint Nutrition Research Unit of the
Council for Scientific and Industrial Research,
and the University of the Witwatersrand,
Johannesburg.

Ncv. 25.

¹ Gillman, J., Gilbert, C., and Spence, I., *Cancer*, 8, 494 (1953).

Effect of Potassium Ions on Brain Slices

We have already analysed the ammonia formation systems in brain tissue as part of a study of the metabolic patterns of the excitatory state in the nervous system¹. We have now extended our investigation to the respiratory and energy-transfer systems. It is well known that both the respiration and lactate formation of brain slices are markedly increased by the addition of potassium chloride, and a similar condition is also induced by electrical stimulation of brain slices².

Slices of guinea pig cerebral cortex were used, and their oxygen uptake was measured in Krebs-Ringer solution containing 0.2 per cent glucose or other substrate by the usual manometric technique at 37° C. Lactate was determined chemically by the method of Barker and Summerson.

First we examined the role of sodium ions in the potassium effect. The extra oxygen uptake caused by potassium chloride was completely inhibited in solutions in which sodium was reduced to less than 15 mM by choline. Lactate formation was increased significantly in sodium-free medium and was not changed further by the addition of potassium chloride. But the effect of 2.4 dinitrophenol (5×10^{-5} M) on the respiration of brain slices was not influenced by

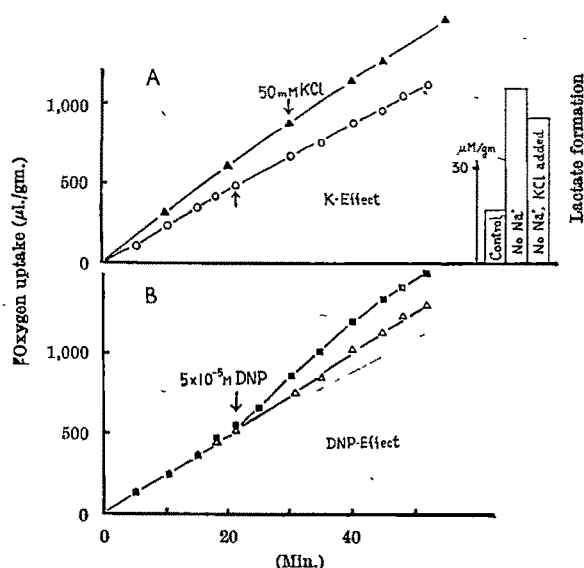


Fig. 1. Sodium ion concentration and potassium- or dinitrophenol-effect when glucose (0.2 per cent) is the substrate. (A) Potassium effect: ▲, 15 mM sodium ions; ○, no sodium ions. Right, aerobic lactate formation during 1 hr. incubation under conditions of no sodium ions. (B) Dinitrophenol effect: ■, 15 mM sodium ions; △, no sodium ions.

sodium ion concentration, and in sodium-free medium it clearly increased the oxygen uptake. These relationships were similarly observed with pyruvate (10 mM) as a substrate, though lactate formation was slight and not increased by potassium chloride or 2-4 dinitrophenol.

The observation of Kimura and Niwa³ that only the extra oxygen uptake due to potassium chloride is completely inhibited by malonate was confirmed, and, when fumarate or oxalacetate was added further, the potassium effect was clearly observed in spite of the presence of malonate.

Table 1

Substrate	Inhibitor	Oxygen uptake ($\mu\text{M/gm./hr.}$)			
		Inhibitor absent		Inhibitor present	
		Control	KCl added	Control	KCl added
Pyruvate, 1 mM	Malonate, 10 mM	64.5	105	61.6	67.3
Lactate, 5 mM	"	61.0	100	—	63.9
Glucose, 0.2 per cent	"	55.0	—	52.1	56.0
Glucose, 0.2 per cent, plus oxalacetate, 10 mM	"	69.2	—	72.0	102
Citrate, 10 mM	Fluorocitrate	57.0	—	41.3	—
Pyruvate, 1 mM	"	56.1	96.9	56.5	78.0
Glucose, 0.2 per cent	Azide, 1 mM	54.5	106	56.2	61.9

Heald⁴ reported that the increased oxidation of lactate in response to electrical impulses is not affected by malonate. But the increased oxidation of pyruvate or lactate by potassium chloride was also inhibited by malonate, when the substrate concentration was reduced to 5 mM in lactate and to 1 mM in pyruvate. Moreover, fluorocitrate, a potent inhibitor of citric dehydrogenase, which was prepared enzymatically, inhibited only the increased respiration due to potassium chloride; sodium azide (1 mM) also had the same effect.

These findings make it likely that respiration activated by potassium chloride is different in nature from normal respiration and that it involves the operation of the citric acid cycle. But the consumption of glucose in the respiring medium by brain slices, which was determined chemically using the method of Nelson, was strikingly inhibited by malonate, although changes in oxygen uptake and lactate formation were not detected. In the potassium effect, glucose consumption was also inhibited by malonate and lactate formation was further increased. It shows that the endogenous respiration takes a chief part in the observed oxygen uptake when the citric acid cycle is blocked in brain slices, and that the citric acid cycle operates also in normal respiration.

Table 2

Condition	Glucose consumption ($\mu\text{mole/gm.}$)	Lactate formation ($\mu\text{mole/gm.}$)	Oxygen uptake ($\mu\text{mole/gm.}$)
KCl (70 mM)			
Malonate (10 mM)			
—	35.9	34.9	54.1
+	4.71	28.0	61.5
—	112	99.0	104
+	63.7	117	44.9

Influence of malonate on the glucose consumption and lactate formation in presence and absence of potassium ion effect. Glucose, initially 2.8 mM; gas phase, air. Duration, 80 min.

Next we studied the content of phosphocreatine in brain slices in the presence of malonate. Inorganic phosphate was measured under the conditions of Lowry and Lopez⁵, phosphocreatine determined by the differential stability as described by Bailey and Marsh⁶. As the incubation medium, 0.05 M glycylglycine buffer Ringer solution was used.

Table 3. CONTENT OF INORGANIC PHOSPHATE AND PHOSPHOCREATINE

Medium	KCl added	Inorganic phosphorus ($\mu\text{mole/gm.}$)	Creatine phosphorus ($\mu\text{mole/gm.}$)
No glucose	—	5.50	0.36
Glucose, 0.2 per cent	—	3.20 3.00	0.86 1.03
Glucose, 0.2 per cent	+	6.16 4.62	0.03 0.18
Glucose, 0.2 per cent plus malonate, 10 mM	—	3.16 3.00	0.82 0.75
"	+	4.48 4.56	0.13 0.22

In the presence of malonate, the amounts of phosphocreatine and inorganic phosphate in brain slices after 40 min. incubation were not altered significantly, and the sudden fall of phosphocreatine through addition of potassium chloride was similarly observed.

From these results it is considered that potassium ions may affect two enzymatic points, one of which is the glycolytic system and the other the pyruvate oxidation system, probably the condensing enzyme. It is of interest that the level of phosphocreatine in brain slices still remains high in spite of the complete inhibition of the citric acid cycle by malonate.

YASUZO TSUKADA
GENKICHIRO TAKAGAKI

Department of Physiology,
School of Medicine,
Keio University,
Tokyo.
Nov. 26.

¹ Tsukada, Y., and Takagaki, G., *Nature*, 173, 1138 (1954).

² McIlwain, H., Buchel, L., and Cheshire, J. D., *Biochem. J.*, 48, 12 (1951). McIlwain, H., *Biochem. J.*, 49, 382 (1951).

³ Kimura, Y., and Niwa, T., *Nature*, 171, 831 (1953).

⁴ Heald, P. J., *Biochem. J.*, 55, 825 (1953).

⁵ Lowry, O. H., and Lopez, J. A., *J. Biol. Chem.*, 162, 421 (1946).

⁶ Bailey, K., and Marsh, B. B., *Biochim. et Biophys. Acta*, 9, 133 (1952).

An Improved Technique for staining Blood Films with Giemsa Stain

DURING recent years, the thick-film method of searching for malaria and other blood parasites has largely displaced thin films, especially in what are called 'field surveys' where hundreds and even thousands of blood films may have to be examined. The stain most used is Giemsa (1 c.c. of stain to 15 c.c. of distilled water). Films are stained by immersion for 20 min. in the diluted stain without previous dehaemoglobinization. While this method gives reasonably good results, it has the disadvantage of deeply staining the envelopes of the erythrocytes which adhere to the slide, even though they have lost their haemoglobin.

If normal saline (0.85 sodium chloride) which has been buffered to pH 7.4 is used instead of distilled water, and the films stained for 30 min., staining is greatly improved. The background is clean because the envelopes of all uninfected cells have been removed. On the other hand, the parasitized cells remain, and in *P. vivax* infections Schuffner's stippling is sharply stained and therefore makes species diagnosis easy.

Giemsa stain diluted with normal saline also improves the picture in thin films; it not only reduces the dense appearance of the normal cells but also improves the stippling and shows up the parasites more strikingly. But it is especially for thick films that this improved technique is likely to be most helpful.

Field's technique gives a cleaner background than does Giemsa diluted with distilled water; but by his technique each film has to be stained separately, whereas by the technique quoted above films can be stained in bulk with good results.

The reason for the improvement may be that saline has the effect of dissolving out any globulin and that haemoglobin in this behaves like a globulin. For solution globulin requires salt solution, and is not soluble in plain water; so it seems possible that in the ordinary way with distilled water more globulin and perhaps even some of the haemoglobin remains unremoved and so gives a darker staining effect.

P. G. SHUTE

Medical Research Council
Malaria Reference Laboratory,
Horton Hospital,
Epsom.
Dec. 30.

Effect of Crystalloid Solutions prepared in Glass Bottles on Human Red Cells

VARIOUS serological techniques employed in blood grouping and allied work involve the washing of human red cells with isotonic solutions, often of saline or sodium citrate.

When carrying out the anti-globulin test¹, it is necessary, after the test cells have been incubated with the serum which may contain a blood-group antibody, to wash them until they have been separated from the serum and are freely suspended in saline. While this washing was being carried out, the cells occasionally became spontaneously agglutinated. This occurrence was observed irregularly, and the strength of the non-specific agglutination was variable. On one occasion, for example, the first washing with an isotonic saline solution produced

no agglutination; but subsequent washing produced a very strong and marked agglutination of the red cells. On most other occasions minor agglutination occurred. In the later stages of the test, the washed red cells are mixed with the diluted antiglobulin reagent upon a microscope slide and stirred with either another glass slide or a glass tube; weak false positive results occurred from time to time. Sometimes, when the antiglobulin reagent was being titrated on a tile and stirring of the test cells and diluted reagent was carried out with a small test tube or the tip of a microscope slide, it was observed that weak positive results were obtained in the higher dilutions and in the control test.

Recent techniques have enabled red cells to be frozen solid, and the method of Chaplin and Mollison² has been used for enabling test cells, and particularly those of rare blood groups, to be stored so that they can be used whenever required in the laboratory. In order to bring these cells from their suspension in glycerol into a saline solution, they may be treated by washing in successive concentrations of trisodium citrate solution. It was noticed from time to time that non-specific agglutination occurred during the washing of these cells with citrate solutions.

The common factor in all these observations was that agglutination of washed cells occurred only in the absence of serum or when its concentration was very low; trisodium citrate solutions were particularly troublesome.

Extensive investigations were carried out in order to determine the cause of the phenomenon, and it was concluded that the presence of glass was an essential feature. If trisodium citrate solutions are autoclaved in glass containers and afterwards frozen, a solution showing strong agglutination of washed erythrocytes is frequently obtained. If the solution is autoclaved in containers of various different glasses, the strength of the effect varies. If the solutions are autoclaved in plastic bags, no agglutination of the washed cells is observed. Similarly, if the solutions are sterilized by Seitz filtration there is no red-cell agglutination.

A similar agglutination of washed erythrocytes can be brought about by placing the washed cell suspension on a microscope slide, stirring vigorously with a glass rod or the corner of another slide and rocking gently. This phenomenon is also inhibited by serum, but is not always completely inhibited by the low concentration of serum in a dilute anti-globulin reagent. This phenomenon seems to be related to the abrasive action of the two glass surfaces on stirring, and it can be avoided by stirring with a soft plastic rod. This effect is a not infrequent cause of difficulties in the last stage of the anti-globulin test.

It seemed to us, from these experiments, that glass (or some component of glass) was responsible for these phenomena, and following consultations with various chemists and physicists (particularly Mr. D. C. Henry, of the University of Manchester) a solution of colloidal silica was prepared.

It was found that a very dilute solution of silica sol would cause an intense aggregation of normal red cells suspended in saline, but aggregation was absent if the red cells were suspended in serum. Activity was still present at very low concentration of silica, for example, of the order of one part per million. Only certain preparations of silica sol showed the phenomenon, and the factors involved in this are being investigated further.

The amount of protein that was required to prevent the agglutination of the cells depended upon the sol that was used. If a very strong one was employed, human serum diluted 1:4 would not prevent the agglutination of washed red cells.

Since it appears that silica (presumably in colloidal solution) can be derived from glass by treatment with water, particularly at a high temperature or at alkaline pH, it seemed that a silica sol might be formed under the conditions previously described, and it was concluded that false positive results might be caused in the antiglobulin test and in other serological techniques by the presence of silica sol in the crystalloid solutions that had been prepared for these tests. The physical aspect of this phenomenon is complicated and it is not proposed to discuss it here.

From a practical point of view, therefore, crystalloid solutions which are to be used for the washing of red cells should not be prepared by autoclaving in glass bottles, nor should they be frozen in glass bottles; but if they have to be heated they should be heated in plastic bags, or sterilization achieved by Seitz filtration; alternatively, solutions may be made up freshly without sterilization or freezing. The ease with which citrate solutions become infected makes it desirable, however, that they should be sterilized by some means; and we, ourselves, use Seitz filtration, making up small quantities which are used only once.

F. STRATTON
P. H. RENTON

National Blood Transfusion Service,
Roby Street,
Manchester 1.

¹ Coombs, R. R. A., Mourant, A. E., and Race, R. R., *Lancet*, ii, 15 (1945).

² Chaplin, jun., H., and Mollison, P. L., *Lancet*, i, 215 (1953).

The N-Terminal Amino-Acid of Rabbit Gamma-Globulin and Antibody

PORTER¹ found that both the anti-ovalbumin antibody and the non-specific γ -globulin of rabbit serum contained the same single N-terminal amino-acid, namely, alanine. Hughes and Sinex² consider this "amazing"; and seeing that the serum component called γ -globulin is a family of proteins that includes diverse antibodies and possibly protein with other functions, and has been shown to be heterogeneous by various physico-chemical criteria, this result is certainly not inevitable.

The N-terminal amino-acid of another rabbit antibody—that against bovine serum albumin—has now been determined together with the end-group of 'inert' rabbit γ -globulin. The method used was the fluorodinitrobenzene method of Sanger³ with paper chromatography (phthalate *tert.*-amyl alcohol) for identification of the dinitrophenyl amino-acids.

The specific precipitate was found to possess one N-terminal alanine per molecule of 156,000. Aspartic acid, corresponding to one residue per molecule of the bovine serum albumin (mol. weight 69,000) in the precipitate, was also recovered. The non-specific γ -globulin yielded 0.91 mol. of alanine/molecule of 156,000 molecular weight; aspartic acid (corresponding to 0.2/mol.) was also found. Even though no serum albumin could be detected in the original γ -globulin preparation by paper electrophoresis, it is possible that this aspartic acid came from contamination with rabbit serum albumin, in quantities too

Table 1

γ -Globulin	Asp.	Glu.	Ser.	Ala.	Val.	Thr.	Leu.
Human II—1, 2 (ref. 5)	1.06	1.82	0.10				
Human II—3 (ref. 5)	1.01	1.06	0.17				
Human II (ref. 4)	1.0	1.0	0.1–0.2				
Human myeloma (ref. 4)	2.0						
Bovine (ref. 5)	0.13	0.15	0.09	0.09	0.11		
Horse (ref. 5)	+	+	+			+	+
Rabbit non-specific	0.2			1.0 (ref. 1) 0.91			
Rabbit, anti-Ba (ref. 1)				1.0			
Rabbit, anti-bovine serum albumin				1.0			

small to be detected by electrophoresis, that is, less than 5 per cent. Less than 5 per cent of serum albumin in the γ -globulin preparation would suffice to account for the aspartic acid found.

These findings confirm Porter's. The γ -globulins of all other species investigated so far, differ from that of the rabbit in having more than one terminal amino-acid per molecule and appearing to be more heterogeneous, in that different fractions of the same γ -globulin have different end-groups. In addition to the species listed in Table 1, Porter⁴ found that pig γ -globulin contains six free α -amino groups. Smith⁵ reports an increase of N-terminal valine in the 'immune globulins' of cattle; these immune globulins, however, are merely fractions containing unknown amounts of antibody, whereas the specific precipitates used by Porter and myself for antibody end-group determination were 90 per cent antibody.

Since antibodies against two different antigens and 'non-specific' γ -globulins (which may include a variety of antibodies) have the same single terminal amino-acid (in the rabbit), it is improbable that this part of the molecule is involved in either of the specific combining groups of the antibody molecule.

I wish to thank Dr. F. Sanger for his help and advice, and for letting me use the facilities of his laboratory.

EVA S. ORLANS

Department of Pathology,
University of Cambridge,
Dec. 23.

¹ Porter, R. R., *Biochem. J.*, **48**, 473 (1950).

² Hughes, W. L., and Sinex, F. M., "Ann. Rev. Biochem.", **23**, 187 (1954).

³ Sanger, F., *Biochem. J.*, **39**, 507 (1945).

⁴ Putnam, F. W., *J. Amer. Chem. Soc.*, **75**, 2735 (1953).

⁵ McFadden, M. L., and Smith, E. L., *J. Amer. Chem. Soc.*, **75**, 2734 (1953).

⁶ Porter, R. R., *Biochim. Biophys. Acta*, **2**, 105 (1948).

⁷ Smith, E. L., *J. Biol. Chem.*, **184**, 345 (1940).

Cup-plate Assay of Serum Fibrinolysin

IN recent years, attention has been given to the quantitative estimation of serum fibrinolysin. Study of the plate test of Permin¹ indicated that some modification of this method was necessary to estimate numerous unknown enzyme samples. The cup-plate assay method described by Dingle, Reid and Solomons² seemed suitable, since it was designed to estimate large numbers of samples over a wide range of enzyme concentrations. We have found that a combination of the principles of these two methods is applicable to the measurement of serum fibrinolysis.

A 0.5 per cent solution of fibrinogen in sodium barbitone-hydrochloric acid buffer pH 8.0 was prepared and kept in a water-bath at 43°. A 4.0 per cent solution of agar in buffer was prepared and cooled to 53°. Equal quantities of these two solutions were mixed with gentle stirring and poured quickly on to an accurately levelled glass sheet, which was bounded by a sealed frame of requisite dimensions. The total volume used was that required to give a final plate depth of 3.25–3.5 mm. After the gel had set, buffered thrombin (Maw) was applied evenly to the gel surface (one 10 ml. thrombin ampoule for a plate area of 1,000 sq. cm.). The plate was then incubated in a humid atmosphere at 37° for two hours, the gel becoming opalescent due to the precipitation of the fibrin in a finely divided form. Excess thrombin was removed, the requisite number of cups were cut with a cork borer of 8 mm. diameter, and filled with 0.1 ml. of enzyme solution. An assay design similar to that of the antibiotic cup-plate assays was used. Most of the findings of Brownlee *et al.*³ were relevant.

The plate was incubated for 18 hr. and measurement was carried out by projecting the lysed zones on to a ground-glass screen. The zone was read by taking the mean of two diameters; with a magnification of 5, the usual range of diameters was 60–100 mm., and the variation between a number of zones of identical enzyme concentration was 2 mm. We have found that with a substrate concentration of 0.25 per cent there is a linear relationship between the logarithm of enzyme concentration and the square of the zone radius over a wide range of enzyme concentrations (Fig. 1).

A sodium barbitone-hydrochloric acid buffer was used, since it gave good pH stability during a prolonged period of enzymatic hydrolysis. The pH optimum curve under these conditions shows a sharp peak at pH 8.0 with 50 per cent loss in activity at pH 9.0 and 90 per cent loss at pH 6.5.

Estimation of serum antifibrinolysin was carried out by prior incubation, for 2 hr. at 37°, of various serum dilutions with a standard enzyme preparation. The resulting activity was expressed as a percentage of the control, and was inversely proportional to the logarithm of the serum concentration between final serum concentrations of 1/3.5 and 1/35.

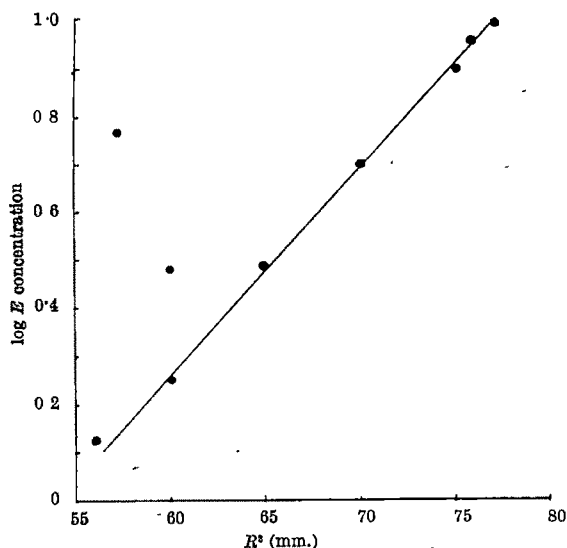


Fig. 1. Relationship between the square of the zone radius and the logarithm of the enzyme concentration

The main advantage of this method is that it is possible to measure numerous enzyme samples under identical conditions. Care must be taken in the choice of commercial fibrinogen preparations, as some batches have an appreciable amount of profibrinolysin adsorbed. Although this does not affect the area lysed by an enzyme preparation, it causes a loss of contrast at the zone edge and consequent difficulty in reading.

We wish to thank Dr. G. D. Kersley for his advice and encouragement.

J. T. M. DINGLE

D. P. PAGE THOMAS

Rheumatism Research Unit of the
South West and Oxford Regions,
Central Laboratory,
Manor Hospital,
Bath.
Dec. 20.

- ¹ Permin, P. M., *Nature*, 130, 571 (1947). "Fibrinolytic Enzymes", thesis, Copenhagen (1949); *Acta Physiol. Scand.*, 20, 388 (1950).
² Reid, W. W., *Nature*, 165, 569 (1950). Dingle, J. T., Reid, W. W., and Solomons, G. L., *J. Sci. Food and Agric.*, 3, 149 (1953).
³ Brownlee, K. A., *et al.*, *J. Gen. Microbiol.*, 2, 40 (1948).

Colour Reagent for Paper Chromatography of Steroids

For the paper chromatography of steroids several colour reagents are used, such as 2,4-dinitrophenylhydrazine, Zimmermann's reagent, phosphomolybdic acid, antimony trichloride, etc. Their common defect is that the reagent gives some colour with the paper itself, and so the contrast between spot and paper is too small. We have found that acid aniline phthalate in alcoholic solution—the reagent Partridge used for tracing sugars¹—is suitable for the indication of steroids as well. On the white background the steroids show as yellow, orange or brown spots.

The sensitivity of the reaction is increased about ten times when *p*-phenylenediamine is substituted for aniline. 2–3 µgm. of steroid gives good, easily distinguishable spots. The reagent is, as shown in Table 1, rather selective. Only steroids containing the Δ^4 -3-keto-group in the A ring show any colour reaction.

Table 1

Reichstein's compound 'S'	+	reddish-brown
Progesterone	+	" "
6,11-Dihydroxyprogesterone	+	" "
11 α -Hydroxyprogesterone	+	" "
Pregnane-3,20-dione	—	
Allopregnane-3,20-dione	—	
Pregnane-3 α -ol-20-one	—	
Allopregnane-3 β -ol-20-one	—	
Testosterone	+	orange
Δ^4 -Androstene-3,20-dione	+	reddish-brown
5-Dehydroandrosterone acetate	—	
Progesterone-20-cyanhydrin	+	brown
Δ^5 -Pregnene-3-ol-20-one	—	
Δ^5 ,16-Pregnadiene-3-ol-20-one	—	
Δ^4 ,16-Diene-3,20-dione	+	yellow
isoErgosterone	+	orange
Δ^4 ,22-Ergostadiene-3-one	+	brown
Δ^22 -Coproergostene-3-one	—	
22,23-Dibromergost-8-ene-1-one-3-acetate	—	
Δ^1 ,4-Adrostadiene-3,20-dione	+	yellow

The colour reaction can be carried out with oxalic acid in place of phthalic acid, or with α - or β -naphthylamine in place of aniline.

Use of the new reagent led us to the interesting observation that chloroform solutions of progesterone and 11 α -hydroxyprogesterone gave after some weeks of standing a much stronger colour reaction than fresh solutions. In such solutions a new compound was formed—perhaps by oxidation—which could be

shown by paper chromatography (in a propylene glycol-toluene system) as a very slowly moving spot.

A. BODÁNSZKY
J. KOLLONITSCH

Research Institute of the
Pharmaceutical Industry,
Budapest. Oct. 11.

¹ *Nature*, 184, 443 (1949).

Detection of Iodine-containing Compounds on Paper Chromatograms

Bowden, MacLagan and Wilkinson have described¹ the use of the ceric sulphate-arsenious acid reaction for the detection of micro-quantities of iodine-containing compounds on paper chromatograms. A difficulty encountered in this laboratory was the fading of the background colour due to the presence of traces of iodine in the atmosphere. This can be prevented by spraying the chromatograms, immediately on completion of the catalytic reaction, with a 1 per cent solution of *o*-phenylenediamine in acetone and drying in air. The stable chocolate-coloured background formed by reaction of excess ceric sulphate with the amine gives a greatly increased contrast with the white spots, and the life of the chromatogram is limited only by the decomposition of the cellulose by the acid present in the original reagent.

K. FLETCHER
P. G. STANLEY

Department of Clinical Research,
University College Hospital Medical School,
London, W.C.1. March 1.

¹ Bowden, C. H., MacLagan, N. F., and Wilkinson, J. H., *Biochem. J.*, 59, 93 (1955).

The System Niobium-Silicon and the Effect of Carbon on the Structures of Certain Silicides

THE phase diagram of the niobium-silicon system has been established by melting-point determinations, X-ray examination and metallography, and is shown in Fig. 1. Alloys were prepared in the form of beads weighing 1-2 gm. by melting the constituents together in an argon arc-furnace¹; the metals used were 'Matthey' standards and the silicon was Johnson, Matthey and Co.'s 'Hyperpure'. Melting-point measurements were made in the furnace by a technique described earlier².

Three intermediate phases, Nb₄Si, Nb₅Si₃ and NbSi₂, are present in the system. That of composition Nb₄Si is formed peritectically at about 1,950° C. from Nb₅Si₃ and the melt. From metallographic and X-ray examinations, it is evident that this compound is isomorphous with Ta₄Si and Zr₄Si, but the DO₁₉ structure of the Ta₄Si phase reported by Kieffer, Benesowsky, Nowotny and Schachner³ has not been detected in alloys arc-melted from components of high purity. The phase Nb₅Si₃ melts congruently at 2,480° C., and exists in two modifications, 'α-Nb₅Si₃' stable at low temperatures, and 'β-Nb₅Si₃' the high-temperature phase. The α-β transformation lies between 1,900° and 2,100° C. Phases with structures corresponding to α- and β-Nb₅Si₃ have been found in systems of silicon with the neighbouring transition metals of Groups IV, V and VI. Powder photographs of arc-melted specimens of V₅Si₃, Cr₅Si₃, Mo₅Si₃ and W₅Si₃ suggest that these compounds are isomorphous with the β-form of Nb₅Si₃, and that arc-melted Ta₅Si₃ is isomorphous

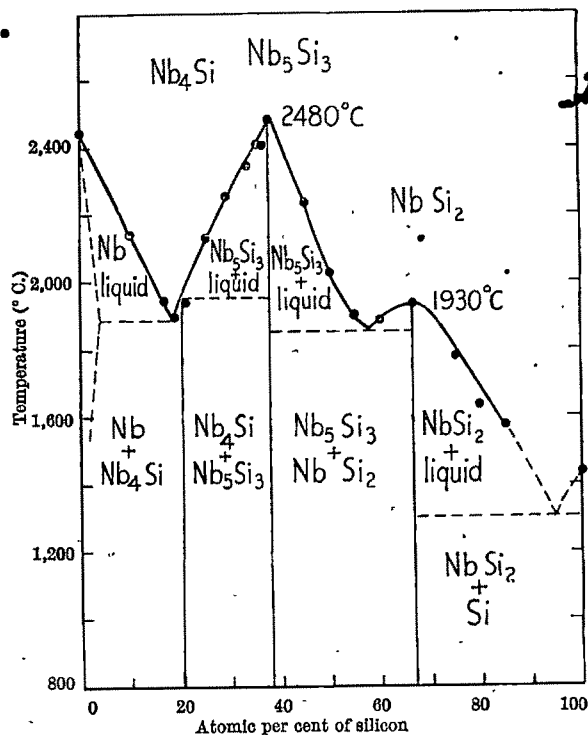


Fig. 1. Niobium-silicon system. •, Observed melting points

with the α-form. In an investigation of alloys prepared by hot-pressing in graphite moulds, Schachner, Cerwenka and Nowotny⁴ determined the structures of several silicides of the composition M₅Si₃. They reported that V₅Si₃, Mo₅Si₃ and Nb₅Si₃ had the D8₁ structure, but this structure was not found in the arc-melted silicides used in the present work. Carbon is a very probable contaminant in hot-pressed samples and to determine whether carbon contamination accounts for the discrepancy in results, the M₅Si₃ silicides were re-melted in the arc furnace with 1-2 wt per cent of coconut charcoal. In all cases the addition of carbon caused the formation of D8₁ structures.

The melting point of NbSi₂ has been determined as 1,930° C., and a eutectic is formed between this compound and Nb₅Si₃ at 1,850° C. and 58 atomic per cent silicon. At the niobium end of the diagram silicon lowers the liquidus to about 1,880° C., the eutectic temperature between Nb₄Si and niobium. The terminal solubilities of silicon in niobium and niobium in silicon have not been investigated. An appreciable solubility of silicon in niobium is probable, a lattice expansion of 3.299-3.308 kX. being observed in powder compacts sintered at 1,300° C.

I thank Dr. G. A. Geach for suggesting this investigation, and for his continued interest in it and also Dr. T. E. Allibone, director of the Associated Electrical Industries Research Laboratory, for permission to publish this communication.

A. G. KNAPTON

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston Court,
Aldermaston, Berkshire. Dec. 8.

¹ Geach, G. A., and Summers-Smith, J. D., *Metallurgia*, 42, 153 (1950)

² Geach, G. A., and Summers-Smith, J. D., *J. Inst. Met.*, 80, 143 (1951)

³ Kieffer, R., Benesowsky, F., Nowotny, H., and Schachner, H. *Z. Metall.*, 44, 242 (1953).

⁴ Schachner, H., Cerwenka, E., and Nowotny, H., *Mh. Chem.*, 8, 245 (1954).

Structure of the ω -Precipitate in Titanium-16 per cent Vanadium Alloy

In many titanium alloys the body-centred cubic phase, stable at high temperatures, can be retained on quenching. When re-heated to temperatures below 500° C., the alloys may first become hard and brittle. This has been associated with the precipitation of an intermediate phase termed ω ¹.

Single-crystal X-ray work has been carried out on titanium-16 per cent vanadium alloy to determine the structure associated with the hard and brittle condition. Samples of 0.014 in. thick sheet were heated in vacuum for 2 hr. at 1,250° C. to produce crystals up to 5 mm. in diameter. The specimens were afterwards re-heated for 30 min. at 900° C. in argon and quenched in water. Some crystals were aged for 5 min. at 460° C. in molten tin, a treatment leading to high hardness and brittleness. Suitable crystals were thinned to 0.005 in. by solution in acid and orientated with $[100]\beta$ vertical. Oscillation and stationary crystal photographs were obtained using molybdenum $K\alpha$ radiation.

Both the quenched and aged crystals showed diffractions in addition to those from β -titanium. The additional diffractions (presumably due to ω -precipitation) were elongated and joined by diffuse streaks in the photographs of the quenched crystals. The extra diffractions from the aged crystals were all sharp, so that the particles of precipitate would be greater than 300 Å. in all directions. The additional diffractions occurred on layer lines, Fig. 1, and could be indexed on a cubic lattice with axes parallel to those of the original β -titanium, but three times as large. The indices were simplified by transforming to a hexagonal cell with $a_\omega = 4.60$ Å. and $c_\omega = 2.82$ Å., and oriented so that $[0001]\omega // [111]\beta$ and $(1120)\omega // (1\bar{1}0)\beta$; consequently, there are four possible orientations of ω in a given β -crystal.

Fair agreement between calculated and observed intensities was obtained with the atom positions 000 , $\frac{1}{3} \frac{2}{3} \frac{1}{2}$ and $\frac{2}{3} \frac{1}{3} \frac{1}{2}$.

The relation between the structure of β -titanium and the proposed ω -structure is most easily revealed by a $(111)\beta$ plane projection (see Fig. 2). Every second and third plane of β amalgamates into one plane in the ω -structure.

The spots from the quenched crystals were elongated in $\langle 110 \rangle \beta$ directions, showing lack of

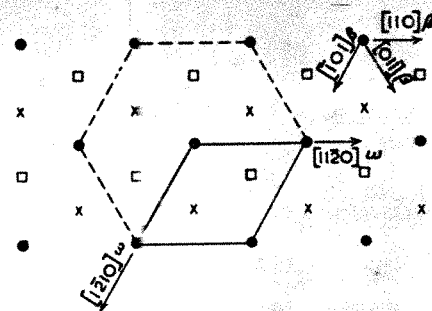


Fig. 2. Projection of atomic positions on $(111)\beta$ and $(0001)\omega$ planes. The parameters of ω are $a = 4.60$ Å. and $c = 2.82$ Å.

Key:

β	z co-ordinates	ω	
●	0 and + 2.82 Å.	●	0 and + 2.82 Å.
×	+ 0.94 Å.	×	and □ + 1.41 Å.
□	+ 1.88 Å.	□	

periodicity in the $\langle 1120 \rangle \omega$ directions. The ω -precipitate may be in the form of platelets parallel to $\{1120\}\omega$ and $\{110\}\beta$ planes; but the hypothesis needs further testing.

Full details will be published elsewhere. This work forms part of the research programme of the Royal Aircraft Establishment, and acknowledgment is made of the help of Mr. H. Brooks and Dr. H. W. Rayson, of the Metallurgy Department of the Establishment, and of permission to publish granted by the Chief Scientist, Ministry of Supply.

J. M. SILCOCK
M. H. DAVIES
H. K. HARDY

Fulmer Research Institute,
Stoke Poges, Bucks.
Dec. 23.

¹ Frost, P. D., Parris, W. M., Hirsch, L. L., Dolg, J. R., and Schwartz, C. M., *Trans. Amer. Soc. Metals*, **46**, 231, 255, 1056, 1073 (1954).

Equilibrium of Hydrogen-Bond Formation in the Excited State

In the course of studies on the influence of the addition of a proton acceptor upon the fluorescence of aromatic compounds, which are proton donors, we have found evidence that the excited molecules in many cases have a greater tendency to form hydrogen bonds and that a new equilibrium is reached during the life-time of the excited state. Taking β -naphthol as the fluorescent substance (proton donor), for example, we have examined the effects of the addition of several proton acceptors such as dioxane, methyl, ethyl and n -butyl acetate, ethyl chloracetate and others upon the fluorescence and absorption spectra and upon the intensity of fluorescence of β -naphthol dissolved in n -hexane.

In the case of ethyl chloracetate, a remarkable quenching of fluorescence was observed; but all the other substances cited cause the intensity to increase somewhat. Some examples showing the relative intensities, f/f_0 , plotted against the concentrations of proton acceptors are shown in Fig. 1. Some changes of the absorption and fluorescence spectra characteristic of hydrogen-bond formation are, of course, observed in all cases.

The fluorescence and absorption of β -naphthyl methyl ether in n -hexane are not affected by the above substances, whereas carbon tetrachloride quenches the fluorescence of both β -naphthol and

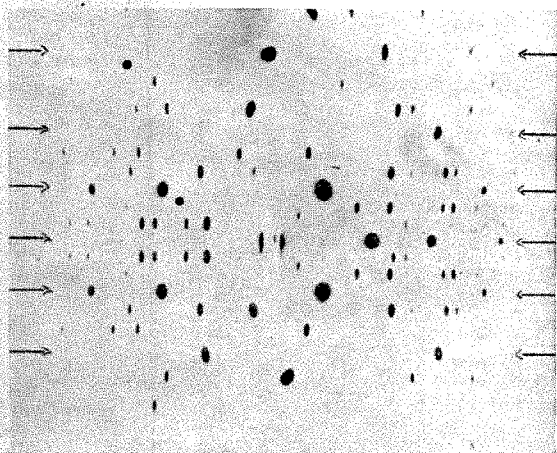


Fig. 1. Oscillation film from titanium-16 per cent vanadium alloy aged 5 min. at 460° C. $[001]\beta$ vertical; molybdenum $K\alpha$. Arrows indicate β -titanium layer lines

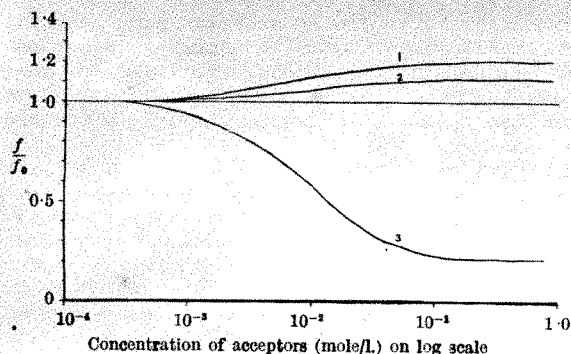


Fig. 1. Concentration effect of proton acceptors on the relative fluorescence intensity of β -naphthol in *n*-hexane (5×10^{-4} mole/l.): (1) butylacetate; (2) methylacetate; (3) ethyl-chloracetate

β -naphthyl methyl ether in the same order of magnitude. These observations show that the changes mentioned above of intensity of fluorescence are due to hydrogen-bond formation.

If the equilibrium of hydrogen-bond formation in the ground-state is not perturbed during excitation, then one may set up the following scheme for the process of fluorescence:

Process	Rate or equilibrium
$D + A \xrightleftharpoons[k_2]{k_1} DA$	$K = k_1/k_2 = [DA]/([D][A])$
$D + h\nu \rightarrow D^*$ $DA + h\nu \rightarrow DA^*$	light absorption $I_{\text{abs}}[D]/([D] + [DA])$ $I_{\text{abs}}[DA]/([D] + [DA])$
$D^* \rightarrow D + h\nu_f$ $DA^* \rightarrow DA + h\nu_f'$	emission of light $k_f[D^*]$ $k_f'[DA^*]$
$D^* \rightarrow D$ $DA^* \rightarrow DA$	quenching process $k_q[D^*]$ $k_q'[DA^*]$

where D and A are respectively β -naphthol and a proton acceptor, and the other notations have the usual meaning.

On the basis of this scheme the following relation can easily be derived if one assumes, as in practice, that the extinctions of the wave-length of excitation of A and AD are equal:

$$\frac{f}{f_0} = \frac{1 + \alpha K[A]}{1 + K[A]} \quad (1)$$

where f_0 is the intensity of fluorescence of the pure β -naphthol solution, f is that of the system containing a certain proton acceptor, and α is the ratio of the quantum yields of fluorescence in the two cases.

If, on the other hand, a new and different equilibrium state for hydrogen-bond formation is realized during the life-time of the excited molecule, then a relation similar to (1) still holds, but in this case K is related to the excited molecule. Hence in this

case K obtained from the data of fluorescence intensity ($K(f)$) may be different from that obtained from the absorption spectra ($K(a)$), whereas if the equilibrium state is maintained, $K(a)$ and $K(f)$ must coincide.

Formula (1) agrees with the experimental observations very exactly. The K -values obtained from it, however, are different from those of $K(a)$ obtained from the absorption spectra by the method of Rosenblatt².

The free energy of hydrogen-bond formation as calculated from $\log K(a)$ and $\log K(f)$ are tabulated in Table 1. Probable errors would be less than ± 0.05 . Thus, in all cases $|\Delta F(f)|$ is greater than $|\Delta F(a)|$, and we may conclude that the equilibrium shifts toward hydrogen-bond formation to some extent during the life-time of the excited molecule.

NOBORU MATAGA
YOZO KAIBE
MASAO KOIZUMI

Polytechnic Institute,
Osaka City University,
Osaka. Nov. 17.

¹ Nagakura, S., and Baba, H., *J. Amer. Chem. Soc.*, **74**, 5693 (1952).
Nagakura, S., *J. Chem. Soc. Japan*, **75**, 734 (1954).

² Rosenblatt, D. H., *J. Phys. Chem.*, **58**, 40 (1954).

An Early Electric Valve

ALTHOUGH the Edison effect was discovered some twenty years before the thermionic valve was patented, it is perhaps not generally known that the rectification of a current by an electric valve had taken place as early as 1863.

P. Riess, in a paper entitled "On the Electrification of the Magnetic Needle by the Secondary Currents of a Leyden Battery"¹, describes the repetition of some experiments carried out originally by M. Gaudin in which "an apparatus called the electric valve" was used. The valve consisted of a glass cylinder inside which were a brass disk 25 mm. in diameter and a separate platinum wire. The distance between the disk and the point of the wire was about 2 mm. When the cylinder was evacuated, a current was found to pass through it from the plate to the wire if the pressure was "not less than 2 lines or greater than 5 inches of mercury". From his experiments Riess formulated the rule: "By means of the electrical valve, and in any position, the secondary current of the Leyden jar deflects the magnetic needle in the direction of a current proceeding from the disk to the wire". This is tantamount to saying the current passes in one direction only, or that rectification has taken place.

D. B. McNEILL

Physical Laboratory,
University,
Southampton.

¹ Riess, P., *Phil. Mag.*, **27**, 313 (1864); *Monats. Berl. Akad.* (Nov. 1863).

Relation of Radon to Non-active Air Contamination

Anderson, Mayneord and Turner¹ have directed attention to the variation of atmospheric radon content. It may be of interest to note that similar observations were made here during the four months, November-February, 1953-54. Samples were collected daily from air drawn through four-inch filter paper TFA-41. The activity of the papers was determined by inserting them directly into an ionization chamber with a vibrating-reed type amplifier

Table 1
(in kcal./mol.)

	$\Delta F_{283}^{(f)}$	$\Delta F_{283}^{(a)}$	$\Delta F_{283}^{(f)} - \Delta F_{283}^{(a)}$
Dioxane	1.6 ₈	1.50	0.1 ₈
Butyl acetate	2.8 ₀	1.80	1.0 ₀
Methyl acetate	2.4 ₈	1.82	0.6 ₆
Ethyl acetate	2.0 ₄	1.67	0.3 ₇
Ethyl chloracetate	1.8 ₈	1.29	0.5 ₉

and an inked pen recorder. A second set of observations was obtained by the more laborious counting of beta-emission with a mica window counter.

Identification of the activity as radon products was obtained by tracing the decay through periods longer than two hours, and indicated that the majority of activity was of this origin, although a tail of activity of longer life, probably thoron, could also be traced. No attempt was made to identify the type of dust collected; but its density was measured by comparing the light transmitted to that of a clean filter paper by a photoelectric densitometer. Although variations in radon over this period were considerably less (under a 20 to 1 maximum) than instances quoted by Anderson *et al.*, the correlation with dust present was strikingly evident. The correspondence with visibility was observed but less amenable to exact quantitative check.

These observations were taken in Morgantown, West Virginia, where coal is a common domestic and commercial fuel. Observations with improved apparatus are now in progress.

C. D. THOMAS
M. K. GAINER
T. W. BALL

Department of Physics,
West Virginia University,
Morgantown. Nov. 24.

¹ *Nature*, 174, 424 (1954).

Control of Diurnal Rhythms of Activity in *Periplaneta americana* L.

In a previous communication¹ it has been shown that a secretion carried in either the blood or tissues is involved in the production of a diurnal rhythm of activity in *Periplaneta americana* L.

It has now been found that the sub-oesophageal ganglia can in certain conditions evoke a diurnal rhythm of activity. The normal diurnal rhythm, consisting of a burst of activity in the first hours of darkness followed by a decrease in activity and finally a very low level of activity in the light, is disrupted by the removal of the head of a cockroach. Implantation of sub-oesophageal ganglia into headless cockroaches is found to be followed, in constant light or darkness, by an activity rhythm closely similar to that of the donor cockroach. The presence of neurosecretory cells in the sub-oesophageal ganglion has been demonstrated by Scharrer², and it would seem reasonable to suppose that they are concerned in the above effect.

Further experiments suggest that the ocelli are the sensory receptors acting as overall timekeepers or governors for the rhythm. Cutting the ocellar nerves, or destroying or covering the ocelli, results in a gradual loss of the normal rhythm, and in the production of a new active phase during the light period. There is a higher activity during this phase than was shown in the light period by beheaded and implanted cockroaches; the increase is probably the result of stimulation of the compound eyes, since it is eliminated if these are blackened.

After a period in constant darkness, cockroaches with cut ocellar nerves will not take up a rhythm of activity under new light conditions, provided that the compound eyes are covered. If the eyes are normal, then the cockroach is active in the light period but shows no carry-over of the rhythm in constant darkness. It is therefore not showing a true diurnal

rhythm, which implies an ability to carry over the old rhythm under uniform environmental conditions rather than a simple reaction to immediate environmental effects. Covering the compound eyes alone and leaving the ocelli normal does not affect the rhythm.

Implanting a sub-oesophageal ganglion from a cockroach which has a normal rhythm into an intact cockroach which has been kept in constant darkness or light and has lost its rhythm causes the implanted cockroach to take up a normal rhythm. On the other hand, implanting a sub-oesophageal ganglion into an intact cockroach having the same rhythm as the donor does not cause any change in rhythm but is followed by a depression in the level of activity in the dark period.

JANET E. HARKER

Sub-department of Entomology,
Department of Zoology,
University of Cambridge.

¹ Harker, J. E., *Nature*, 173, 630 (1954).

² Scharrer, B., *J. Comp. Neurol.*, 74, 93 (1941).

Digestion and the Production of Sulphuric Acid by Mollusca

WHILE investigating the food of aquatic Mollusca in Uganda, it was observed that cellulose in the gut contents was being digested. *Caelatura hautecoeuruelli* (Bgt.), a bivalve, was selected for detailed study and also *Melanoides tuberculata tuberculata* (Müll.), a snail, which belongs to the Prosobranchia, some members of which possess a crystalline style¹.

Preliminary experiments showed that cellulase contained in the crystalline styles of both *Caelatura* and *Melanoides* was more active at pH 5.5 than at pH 7.0, and that the alimentary canal in both species had an acid reaction.

Style material, obtained from several specimens of *Caelatura*, was dissolved in a citric-phosphate buffer solution at pH 5.5 and its effect observed on a uniform suspension of precipitated cellulose^{2,3}. Aliquot portions of the cellulose suspension and style solution were dispensed into duplicated series of small test-tubes and incubated at 24° C. for 36 hr. At the end of this period, the amount of cellulose remaining was determined by turbidity methods, and any soluble sugars produced were estimated by means of alkaline picric acid. The results showed a reduction of cellulose and a rise in sugar content in those tubes containing style material. Similar results were obtained using style material from *Melanoides*.

A small amount of a commercial preparation containing penicillin and streptomycin was added to one set of tubes; this did not prevent hydrolysis of the substrate. Another set of tubes was boiled and immediately cooled. No cellulase activity was observed after this treatment. It seems, therefore, that the cellulase enzymes present in the styles of these two molluscs are similar to those found in the oyster and mussel².

Experiments were carried out to determine whether style solution was active against the cell walls of algae. Phytoplankton from Lake Victoria and two species of filamentous alga were used as a source of cellulose in experiments similar to the above. Break-down of the cell walls of many of the Green and Blue-Green Algae present was observed. It seems that these molluscs are able to utilize sources of food largely unexploited by other groups of aquatic

herbivores. The diatom flora was not affected by the cellulase, a result in keeping with the siliceous nature of their cell walls. Apparently undamaged and viable diatoms are found frequently in snail faeces. This contrasts strongly with the fact that these plants form a very important part of the food of other herbivores⁴.

A short length of gut, including the crystalline style, was taken from several specimens of *Melanoides*, macerated in a drop of distilled water and centrifuged. The supernatant solution was then analysed in order to determine the nature of the acid secreted. The chloride content did not prove high enough for estimation, but sulphate was present in a concentration of approximately 3.0 gm. per litre. This is of particular interest as sulphates in the waters and soils around Lake Victoria are present only in very small amounts and are frequently undetectable by normal chemical methods. Similar results were obtained using material from *Caclatura*.

A direct estimation was made of the inorganic solutes liberated into a small volume of water by various species of snails. In one experiment with *Melanoides*, for example, 0.05 mgm. sulphate was produced per snail in 12 hr.

It has been suggested that the fertility of many lakes in East Africa is controlled by the availability of dissolved sulphate⁵, and by the activity of herbivores⁶. The observations indicate that both gastropods and bivalves have a favourable effect on fertility from both these points of view. Further work on these and other molluscs may show that their metabolism, in those waters in which they are abundant, has a significant effect on fertility.

I am grateful to Mr. C. C. Cridland of this Organization for identifying the Mollusca named above.

G. R. FISH

East African Fisheries Research Organization,
Jinja, Uganda.
Dec. 13.

¹ Yonge, C. M., *Nature*, 142, 464 (1938). Morton, J. E., *Proc. Linn. Soc. Lond.*, 164, 240 (1953).

² Scales (1915), quoted by Stephenson, M., "Bacterial Metabolism", 313 (Longmans, Green and Co., 1949).

³ Newell, B. S., *J. Mar. Biol. Assoc. U.K.*, 32, 491 (1953).

⁴ Fish, G. R., *Nature*, 167, 900 (1951). East African Fisheries Research Organization, Annual Report (1950).

⁵ Beauchamp, R. S. A., *Nature*, 171, 769 (1953).

⁶ East African Fisheries Research Organization, Annual Report (1952).

Reappearance of *Ocenebra erinacea* (L.) off the East Coast of England

ON the east coast of Britain three genera of Muricid drills, *Nucella*, *Urosalpinx* and *Ocenebra*, attack lamellibranchs. Of these, *Nucella* appears to have maintained its population status; but the abundance of the other two has undergone considerable changes. *Urosalpinx*, the American whelk tingle, has gradually increased during this century¹, whereas *Ocenebra* has twice suffered virtual extinction on the east coast by cold winters: 1928-29² and 1939-40 followed by 1940-41³. So far as is known, *Ocenebra* on the south coast of England was not affected.

There are now signs of reappearance of *Ocenebra* on the east coast. Newell⁴ has found living specimens at Whitstable. Although none was found in recent surveys of the Rivers Roach, Crouch, Blackwater, Colne and Orwell, nor in Hamford Water, viable spawn has been found in Orford River. A substantial

area has been trawled and dredged regularly since 1950 off Clacton-on-Sea and the approaches to the River Colne, but only dead shells of *Ocenebra* were recorded. In August 1954, however, in three separate hauls, five live *Ocenebra* were taken from the trawl near the Priory Spit buoy, two miles south-east of the mouth of the River Colne. In September 1954 two further live *Ocenebra* were taken from near the Outer Ridge buoy, about one mile south-east of the mouth of the Rivers Stour and Orwell. The specimens were all small, mostly of no more than about one to two years old.

The appearance of young individuals, in an area previously free from adult *Ocenebra*, indicates the beginning of recolonization. It may be significant that the competitor *Urosalpinx* has not so far been recorded in Suffolk.

It will be interesting to observe whether *Ocenebra* can re-establish itself in the rivers of Essex, in view of the large numbers of *Urosalpinx* there.

M. N. MISTAKIDIS
D. A. HANCOCK

Fisheries Laboratory,
Burnham-on-Crouch,
Essex.
Dec. 17.

¹ Hancock, D. A., *J. Cons. Int. Explor. Mer.*, 20, 186 (1954).

² Orton, J. H., and Lewis, H. M., *J. Mar. Biol. Assoc. U.K.*, 17, 301 (1931).

³ Cole, H. A., *J. Mar. Biol. Assoc. U.K.*, 25, 477 (1942).

⁴ Newell, G. E., *Ann. Mag. Nat. Hist.*, 7, 321 (1954).

Control of Crabs with Crude BHC

CRABS, of which the commonest is *Sesarma africanum*, H. M. Edw., are numerous on the tidal rice lands of Sierra Leone and destroy large numbers of newly planted rice seedlings. In normal farming practice, this has little appreciable effect on yields as sufficient seedlings are planted in each stand to allow for losses. In the past three years, however, there has been a considerable increase in the crab population on the farm of the West African Rice Research Station, and serious damage has been caused to experimental material.

Control of these crabs is complicated by the fact that river water is used for drinking purposes by the local population and that fishing is widespread. Generally toxic substances cannot, therefore, be used.

Preliminary experiments have now shown that crude BHC is effective against the crabs as a contact poison. The results of prolonged contact with aqueous suspensions of varying concentrations were as follows:

65 p.p.m. crude BHC caused death within 4 hr.
6.5 p.p.m. crude BHC caused death within 24 hr.
0.65 p.p.m. crude BHC caused complete lack of co-ordination within 24 hr. but no death within 72 hr.
0.065 p.p.m. crude BHC, no effect observed.

After momentary contact with a concentration of 650 p.p.m. crude BHC followed by thorough washing, death was caused within 24 hr., and under field conditions spraying with concentrations as low as 325 p.p.m. gave adequate protection to young rice seedlings.

These trials were carried out in a season of high tides and heavy rain, and it is probable that during the dry season even greater economy of spray could be obtained.

The investigations are being continued. Other methods of control are also being tried.

H. D. JORDAN

West African Rice Research Station,
Rokupr, Sierra Leone.
Nov. 30.

Deoxyribonucleic Acid and Ribonucleic Acid in Hyphal Cells of Higher Fungi

THE importance of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) in the physiology of a cell is very great. Very little work on cells of fungal hyphae seems to have been done. For this purpose, very young (2-3 days old) subcultures of *Polyporus ostreiformis*, *Polyporus adustus*, *Polyporus gilvus* and *Marasmius campanella* were taken; they were fixed and stained for 15-20 min. by the method of Unna as adapted by Brachet¹. The small resting nuclei of the homogeneous unexpanded type of Pinto Lopes² became very prominent in pyronin-stained cytoplasm; nucleolus and chromatin, combined at the centre into a homogeneous mass, took brilliant green stain (DNA) surrounded by pink hyloplasm (RNA), and finally by a green outline (Fig. 1). The nucleolus, according to Brachet³ and Caspersson⁴, is believed to be composed mainly of ribonucleoproteins, and Fujii⁵ holds that zinc, in addition, is present in nucleoli and that, upon the initiation of mitosis, zinc passes into chromosomes and possibly also into prometaphase spindle.

Nuclei of fungal hyphae being extremely small, Unna staining will be of additional help in distinguishing the haploid from the diploid states by the respective sizes of the nuclei.

DNA in the nuclei is rather of a transitory nature, hence all the nuclei in a mycelium do not take the same prominent methyl green stain. There are differences of opinion as to whether DNA becomes prominent in the nuclei immediately before mitosis or during the early stages of prophase.

In Cyanophyceae the presence of a distinct nucleus (central body) is a matter of dispute. Biswas⁶, working with *Oscillatoria* and *Calothrix* species of this group, could not obtain the methyl green stain of the central body (that is, the presence of DNA), and he thinks that DNA has not been highly polymerized in this lower group. Kurnick⁷ holds that DNA is in a highly polymerized state and RNA is in a non-polymerized state, and therefore DNA takes on methyl green stain and RNA takes on pyronin stain. The specific character of these two dyes for the two nucleic acids has been confirmed by Sharma and Bhattacharjee⁸ working on different plant materials (*Allium cepa*, *Zephyranthus longifolia*, etc.).

Evidence has been brought forward to show that ribonucleic acid plays an important part in protein synthesis⁹, while accumulation of data by S. Zamenhof¹⁰ strongly suggests that the composition of deoxy-

ribonucleic acid is independent of the environment and, as such, it seems to be a hereditary determinant.

It is hoped that further work will gradually clarify these points.

Note added in proof. From Ledoux's (*Nature*, 175, 258; 1955) recent communication, it appears that cellular multiplication of proliferating cells in carcinoma of mouse and rat can be modified through changes in the level of ribonucleic acid by the administration of ribonuclease both *in vitro* and *in vivo* experiments with animals. This, he holds, compares favourably with the results obtained with amphibian eggs and with those of Brachet (*Nature*, 174, 876; 1954) with onion root tips; ribonuclease diffusing across the cell membrane has a very clear anti-mitotic effect.

S. R. BOSE

Carmichael Medical College,
Botanical Laboratory,
Calcutta, India. Feb. 28.

¹ Brachet, J., *Quart. J. Micro. Sci.* (Third Series, No. 25), 94, 1 (1953).

² Pinto Lopes, J., *Portug. Acta Biol.*, (A), 2, 198 (1948).

³ Brachet, J., *Arch. Biol.*, 53, 207 (1942).

⁴ Caspersson, T., *Symp. Sec. Exp. Biol.*, 1, 127 (1947).

⁵ Fujii, T., *Nature*, 174, 1108 (1954).

⁶ Biswas, B. B., *Curr. Sci.*, 22, 346 (1953).

⁷ Kurnick, N. B., *J. Gen. Physiol.*, 33, 243 (1950).

⁸ Sharma, A. K., and Bhattacharjee, D., *Nature*, 169, 417 (1952).

⁹ Gale, E. F., and Folkes, F. P., *Nature*, 173, 1227 (1954).

¹⁰ Zamenhof, S., in "Phosphorus Metabolism", 2, 301 (1952); *Nature*, 165, 756 (1950); *Nature*, 174, 306 (1954).

Effect of Sodium Chloride on Softening and Carbohydrate Changes of Date Fruits

USUALLY Egyptians prefer to consume the date fruits when they are soft (ripe). This softening is either reached normally when the fruits are still on the tree, or it may be hastened by pretreatment of the mature fruits with an aqueous solution of sodium chloride. The latter observation inspired us to study the effect of different concentrations of sodium chloride on the rate of softening of the date fruits as well as on the carbohydrate changes.

The date fruits used in this experiment were picked from one tree and were segregated into homogeneous batches according to the procedure previously suggested by Nada¹. Only the fruits with the highest sugar content were used in the present experiment. These were divided into five equivalent lots, one of which was sliced and extracted in hot alcohol (seed excluded) and finally analysed for the initial carbohydrate fractions. The remaining lots were sterilized in 2 per cent hydrogen peroxide for five minutes, after which each of the lots was soaked for six hours in one of the following solutions: (1) distilled water, (2), (3) and (4) solutions containing 2, 5 and 10 per cent sodium chloride respectively. At the expiry of this experimental period, the dates were again sterilized in hydrogen peroxide, rinsed well with sterile distilled water and finally blotted dry.

After this pretreatment each lot of dates was placed in a well-aerated dark chamber at temperature 30° C., and the experiment continued for 60 hr., after which the softness of the fruits was compared and then they were analysed for their carbohydrate fractions.

It appeared that the dates that had been soaked in solutions 3 and 4 were completely soft; whereas



Fig. 1. *Marasmius campanella*. Arrow shows the nucleus close to the clamp connexion. ($\times 1,800$)

the other lots either showed only slight signs of softening (that in solution 2), or not at all (control in solution 1).

Table 1 shows the carbohydrate content of the date fruit samples before and after experiment calculated in terms of gm. glucose per 100 gm. initial fresh weight.

Table 1

Pretreatment	Reducing sugars	Sucrose	Poly-saccharides	Total
Initial	3.58	22.27	1.06	26.91
6 hr. dis. water + 60 hr. air	6.46	18.84	1.06	26.36
6 hr. 2 per cent NaCl + 60 hr. air	6.80	17.10	1.04	24.94
6 hr. 5 per cent NaCl + 60 hr. air	19.75	3.07	0.95	23.77
6 hr. 10 per cent NaCl + 60 hr. air	19.90	0.93	0.72	21.55

Table 1 reveals that presoaking in distilled water apparently induced decrease in sucrose with a more or less corresponding increase in the reducing sugars. Presoaking in sodium chloride solutions accelerated the disappearance of sucrose and accumulation of hexoses, particularly when 5 and 10 per cent sodium chloride solutions were used. Indeed, the latter not only induced the rapid disappearance of sucrose but also a slight decrease in the polysaccharide content of the dates.

Softening therefore seems to be associated with accumulation of reducing sugars at the expense of sucrose and possibly also some polysaccharides.

I. A. A. NADA

Department of Agricultural Botany,
Faculty of Agriculture,
Ain Shams University, Cairo.

H. M. HASSAN

Department of Agricultural Botany,
Faculty of Agriculture,
University, Cairo.

¹ *Nature*, 175, 469 (1955).

A New Method for Determination of Thickness of Microtome Sections

A METHOD for determining the thickness of microtome sections with the same accuracy as the rest of the analytical procedure has long been required in quantitative cytochemistry. Hitherto this has not been possible, and it has generally been necessary to estimate thickness from the microtome setting, a rather unsatisfactory method.

In 1936 Schmaltz described¹ a method for measuring the profile structure of a surface. This method, the so-called light-cut or light-profile technique, has been further developed by Naumann², Menzel³ and Tolansky⁴. Besides the normal microscopical picture of the object, it also gives information about the depth of profile. A microscope for incident illumination is used in which the objective simultaneously acts as a condenser, and in which the illumination is adjusted according to the Kohler principle. An opaque wire or a phase edge is placed in the plane of the field iris diaphragm, the shadow of which is projected on to the surface under examination. By arranging off-central illumination, differences of level in the surface will give proportional displacements of the shadow line, thus giving the profile of the surface.

In an attempt to apply light-profile microscopy for thickness determinations of histological sections

I have encountered certain difficulties. High accuracy is obtained only when the objective has a large aperture. However, the depth of focus is inversely proportional to the aperture, and since the two levels between which the measurement is made have to be relatively sharp in focus, the working-range is thus considerably reduced.⁵ In fact, if the highest possible accuracy is required, the maximum thickness to be measured in opaque objects is less than 2μ . For cytochemical work, the thickness of the sections generally exceeds 5μ , and it is therefore impossible to determine the thickness with satisfactory accuracy.

In the new method, the principle of the light-cut and light-profile method is employed; but only as an aid to focusing. The thickness proper (equivalent to the movement of the objective) is obtained by a mechanical measuring instrument, a 'mikrokator' (manufactured by C. E. Johansson, Eskilstuna, Sweden), attached to the microscope.

If a profile-microscope is focused on an even surface, the shadow is seen as a sharp line, slightly curved towards the periphery of the field of view. Defocusing in either direction leads to a parallel displacement of the line, which at the same time becomes unsharp and weaker in contrast. This parallel movement is symmetrical around the middle position as regards movement, sharpness and contrast. If a line in the ocular is superimposed upon the line of symmetry, this parallel displacement allows very accurate and reproducible focusing on two different levels in the object. These levels may, for example, be represented by the upper surface of a microtome section and the upper surface of the object slide, that is, the lower surface of the section. The difference between the two levels of focusing is, as mentioned above, measured by a 'mikrokator'. The measuring point of the 'mikrokator' rests upon a horizontal beam attached to that part of the microscope which is moved by the micrometer screw. A 'mikrokator' measuring a vertical movement of the object down to 0.1μ with an accuracy of ± 1 per cent is well suited for this purpose.

Just as in profile microscopy, the accuracy depends upon the structure of the object, the width, sharpness and contrast of the shadow and the aperture and magnification of the objective. In the present method, however, the accuracy is independent of the absolute thickness of the object, which may be as great as 100μ . The method is well suited for routine work, as one measurement involves only two focusings and two readings on the 'mikrokator', which then give the thickness directly in μ .

As a check upon the absolute accuracy of the method, ten measurements were made upon a layer of aluminium evaporated on glass. The average was $3.71 \pm 0.04\mu$; stand. dev. = $\pm 0.12\mu$. This compares well with the thickness measured by multiple interferometry: 3.72μ .

Sections of biological material embedded in paraffin celloidin and plastic may be measured with approximately the same accuracy.

A more detailed report will be published later.

OLLE HALLÉN

Department of Histology,
Faculty of Medicine,
Göteborg, C.
Dec. 3.

¹ Schmaltz, G., "Technische Oberflächenskund" (Berlin, 1936).

² Naumann, H., *Bl. Unters. u. Forsch.-Inst.*, 16, 25 (1942).

³ Menzel, E., *Die Naturwiss.*, 34, 332 (1951).

⁴ Tolansky, S., *Nature*, 169, 445 (1952); *Lab. Pract.*, 291 (1953).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, April 25

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Max Black: "Wittgenstein's Tractatus".

Monday, April 25—Thursday, April 28

PHYSICAL SOCIETY (at the Royal Horticultural Society's New Hall, Westminster, London, S.W.1)—Exhibition of Scientific Instruments and Apparatus.

Discourses (Demonstration Lectures).

Monday, April 25

At 6.15 p.m.—Mr. M. E. Haine: "The Free Electron as a Tool in Scientific Research".

Tuesday, April 26

At 6.15 p.m.—Prof. J. Z. Young, F.R.S.: "Memory Systems in the Brain".

Wednesday, April 27

At 6.15 p.m.—Dr. G. F. J. Garlick: "Recent Developments in Luminescence and Its Applications".

Tuesday, April 26

INSTITUTION OF CHEMICAL ENGINEERS (at the May Fair Hotel, Berkeley Street, London, W.1), at 11 a.m.—Thirty-third Annual Corporate Meeting. 12 noon—Sir Harold Hartley, F.R.S.—Presidential Address.

ROYAL SOCIETY OF MEDICINE, MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Symposium on "Radioactive Isotopes". Speakers—Prof. E. E. Pochin, Prof. D. W. Smithers and Mr. Norman Veall.

ELECTRICAL ASSOCIATION FOR WOMEN (at the Royal Institution, Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Thirty Years of Electrical Progress".

Tuesday, April 26—Wednesday, April 27

SERVICES ELECTRONICS RESEARCH LABORATORY (at Baldock, Herts)—Symposium on "Intermetallic Semi-conductors".

Tuesday, April 26—Thursday, April 28

DUBLIN INSTITUTE FOR ADVANCED STUDIES, SCHOOL OF COSMIC PHYSICS (at 5 Merrion Square, Dublin)—Symposium on "Atmospheric Condensation Nuclei".

Wednesday, April 27

ELECTRICAL ASSOCIATION FOR WOMEN (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 9.45 a.m.—Thirtieth Annual Conference.

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, at the Town Hall, Bournemouth), at 10 a.m.—Discussion on "The Contribution of Processing Techniques to the Nutritional Value of Food".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting.

PHYSICAL SOCIETY, COLOUR GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Discussion on "The C.I.E. System and its Revision".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. A. C. B. Lovell, F.R.S.: "Radio Astronomy and the Fringe of the Atmosphere" (Symons Lecture).

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Dr. W. Idris Jones: "Fuel and Power Research in Britain".

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPY GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. A. G. Gaydon, F.R.S.: "Spectroscopic Evidence on the State of Equilibrium in Flame Gases".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. K. J. Copplin: "Suppressed Aerials for the Aircraft H.F. Band".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting, followed by Dr. J. C. Hudson: "Some Thoughts on the Practice of Applied Science" (Chairman's Address).

Wednesday, April 27—Thursday, April 28

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1)—Annual General Meeting.

Thursday, April 28

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. M. L. E. Oliphant, F.R.S.: "The Acceleration of Charged Particles to Very High Energies" (Bakerian Lecture).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. C. Moore: "A Survey of Some of the Recent Developments in Homotopy Theory".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. M. F. Carroll: "The Commonwealth as a Source of Essential Oils".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5.40 p.m.—Prof. R. Morse: "Wave-guide Propagation in Acoustics".

WOOL EDUCATION SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.15 p.m.—Prof. E. J. Roberts: "Sheep and Wool from the Hills".

Friday, April 29

BRITISH GLACIOLOGICAL SOCIETY (in Room 5, Main Building, The University, Edgbaston, Birmingham 15), at 5.30 p.m.—Prof. F. W. Shotton: "The Midlands in British Pleistocene Geology".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. I. I. Sikorsky: "The Transport Helicopter" (James Clayton Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Hull (April 30).

ASSISTANT LECTURER or LECTURER (preferably with specialist knowledge of systematic botany) in the DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool (April 30).

LECTURER in the DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Liverpool (April 30).

LECTURER or ASSISTANT LECTURER in PHYSICS—The Registrar, The University, Sheffield (April 30).

LECTURER (with a degree in mathematics or statistics and with suitable teaching and/or industrial experience) in MATHEMATICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (April 30).

LECTURER (with special interests in fluid mechanics) in ENGINEERING, and a LECTURER in METAL PHYSICS—The Registrar, University College, Singleton Park, Swansea (April 30).

CHAIR OF PHYSIOLOGY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 5).

LECTURER (honours graduate in metallurgy, and preferably with experience in research and in production metallurgy) in METALLURGY—The Registrar, College of Technology, Manchester 1 (May 7).

LECTURERS (3) in STATISTICS—The Secretary, The University, Aberdeen (May 7).

PHYSICAL CHEMIST or BIOCHEMIST (with an interest in the application of physical methods to biological problems, and preferably with research experience, a knowledge of X-ray diffraction, or ability to handle small quantities of biological material) to join a small team engaged in fundamental research on the structure of plant viruses—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (May 7).

SENIOR LECTURER (graduate of a British university, and with good industrial experience) in TELECOMMUNICATIONS, and a LECTURER (Grade B) (graduate of a British university, and with industrial experience) in ELECTRICAL ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11 (May 7).

LECTURER (first-class honours graduate in mathematics, preferably with a special interest in some branch of applied mathematics or in statistics) in MATHEMATICS—The Registrar, College of Technology, Manchester 1 (May 9).

LECTURER (with high academic qualifications and research experience, and with special interests in inorganic chemistry) in the DEPARTMENT OF CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 9).

LECTURER in ZOOLOGY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 9).

SENIOR LECTURER or LECTURER (with qualifications and experience in chemical engineering) or teaching and research in the sub-department of CHEMICAL TECHNOLOGY, and a LECTURER in ORGANIC CHEMISTRY, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 9).

CHAIR OF ELECTRICAL ENGINEERING, and CHAIR OF MECHANICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (May 14).

LECTURER (with a good honours degree, either in electrical engineering or in mathematics and physics, and preferably with suitable experience in research and teaching in radio and electronics) in ELECTRICAL ENGINEERING—Joint Clerk to the University Court, Queen's College, Dundee (May 15).

LECTURER (preferably with research interests in spectroscopy or the kinetics of gaseous oxidation processes) in PHYSICAL CHEMISTRY—Joint Clerk to the University Court, Queen's College, Dundee (May 16).

LECTURER (with a good honours degree in engineering, and preferably with teaching and research experience in a branch of applied mechanics) in the DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—Joint Clerk to the University Court, Queen's College, Dundee (May 18).

READER in PHYSICAL CHEMISTRY at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 18).

LECTURER in FLUID MECHANICS in the Department of Aeronautics and Fluid Mechanics—The Secretary of University Court, The University, Glasgow (May 20).

PROFESSOR OF APPLIED ELECTRICITY and HEAD OF DEPARTMENT—The Secretary and Registrar, University College of North Wales, Bangor, N. Wales (May 23).

LECTURER or ASSISTANT LECTURER in INORGANIC and STRUCTURAL CHEMISTRY, and a LECTURER or ASSISTANT LECTURER in PHYSICAL CHEMISTRY—The Registrar, The University, Leeds 2 (May 28).

READER in MARINE BIOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, May 31).

PROFESSOR OF THEORETICAL PHYSICS: READER in THEORETICAL PHYSICS; SENIOR FELLOW; FELLOW; SENIOR RESEARCH FELLOWS and RESEARCH FELLOWS in THE RESEARCH SCHOOL OF PHYSICAL SCIENCES, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

ASSISTANT, Grade B (with a degree in chemistry or A.R.I.C., and preferably with industrial and teaching experience), FOR CHEMISTRY to higher national certificate, at Widnes College for Further Education—Borough Education Officer, Lugsdale Road, Widnes.

ASSISTANT PROFESSOR OF MATHEMATICS—The President, Memorial University of Newfoundland, St. John's, Newfoundland, Canada.

LABORATORY TECHNICIAN (Physics)—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1.

LECTURER or ASSISTANT LECTURER in PHYSICS—The Registrar, The University, Nottingham.

LECTURER (with an honours degree in zoology, and preferably with teaching experience) in CHARGE OF BIOLOGY—The Principal, Technical College, Queen Street South, Huddersfield.

READER, SENIOR LECTURERS or LECTURERS (preferably with experience in analytical inorganic chemistry or physical chemistry) in CHEMISTRY—The Dean, College of Arts and Sciences, Baghdad, Iraq.

SENIOR LECTURER in THE DEPARTMENT OF MATHEMATICS, Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (honours graduate (first- or second-class) in science, preferably agricultural chemistry) to carry out research on energy and protein metabolism of animals—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with at least a second-class honours degree in physics) in THE ISOTOPE SCHOOL, to lecture on nuclear physics radioactivity and instruments used in measuring radioactivity; to advise students on physical problems in the use of isotopes; and to develop new instruments and techniques in connexion with the teaching of the Isotope School—The Establishments Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/232.

TECHNICAL ASSISTANTS (with Inter B.Sc. or equivalent qualification, with chemistry as main subject) in the Central Laboratory, London Transport, Chiswick—The Staff Officer (F/EV. 530), London Transport, 55 Broadway, London, S.W.1.

Council for the Promotion of Field Studies. Annual Report, 1953-54. Pp. 60+8 plates. (London: Council for the Promotion of Field Studies, 1955.) [152]

University of Cambridge. Report of the Observatories Syndicate for the year ending 1954, September 30. Pp. 4. (Cambridge: The University, 1955.) [152]

Carnegie Trust for the Universities of Scotland. Fifty-third Annual Report (for the year 1953-54). Pp. iv+72. (Edinburgh: T. and A. Constable, Ltd., 1955.) [212]

Department of Scientific and Industrial Research. Forest Products Research Laboratory. Leaflet No. 47: The Movement of Timbers. Pp. 6. Leaflet No. 48: Hardwoods for Industrial Flooring. Pp. 12. (Ayles: Forest Products Research Laboratory, 1954.) [212]

West African Cacao Research Institute. Annual Report—April 1953 to March 1954. Pp. 62. (London: Crown Agents for Oversea Governments and Administrations, 1954.) 6s. [212]

Other Countries

South Africa. Council for Scientific and Industrial Research, Library and Information Division, Pretoria. Register of Current Scientific Research at South African Universities. Pp. viii+262. (Pretoria: Council for Scientific and Industrial Research, Library and Information Division, 1954.) [72]

Sudan Government. Ministry of Agriculture. Bulletin No. 16. Notes on Cotton Growing from the Research Division. By H. Ferguson. Pp. 52 (Khartoum: Agricultural Publications Committee, 1954.) [72]

World Health Organization. Technical Report Series No. 87. Expert Committee on Onchocerciasis. First Report. Pp. 37. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) 1s. 9d. net; 0.25 dollars; 1 Swiss franc. [72]

The Role of the Pituitary in Cancer: the Clinical Value of Pituitary Lipid Treatment. By Dr. Henry K. Wachtel. Pp. 31. (New York: The William-Frederick Press, 1954.) 2 dollars. [72]

Smithsonian Institution. Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents, for the year ended June 30, 1954. Pp. ix+175+4 plates. (Smithsonian Publication 4182.) (Washington, D.C.: Government Printing Office, 1955.) [72]

South African Council for Scientific and Industrial Research. List of Abbreviations of Names of Societies, Organisations, etc. Compiled by the Library and Information Division. Pp. iv+51. (Pretoria: South African Council for Scientific and Industrial Research, 1955.) [72]

Transactions of the American Philosophical Society. New Series—Vol. 44, Part 6: The Illumination and Polarization of the Sunlit Sky on Rayleigh Scattering. By S. Chandrasekhar and Donna D. Elbert. Pp. iv+643-654+12 tables. (Philadelphia: American Philosophical Society, 1954.) 2 dollars. [72]

Essai de Prévention de la Silicose Par L. Dautrebande, D. Cartry, J. Van Kerkom et A. Cereghetti. Pp. 177. (Bruxelles: Union Minière du Haut-Katanga, 1954.) [72]

American Philosophical Society. Cumulative Record of Exhibition Catalogues. The Pennsylvania Academy of the Fine Arts, 1807-1870; The Society of Artists, 1800-1814; The Artists' Fund Society, 1835-1845. Compiled and edited by Anna Wells Rutledge. Pp. v+450. (Memoirs of the American Philosophical Society—Vol. 38.) (Philadelphia: American Philosophical Society, 1955.) 6 dollars. [72]

U.S. Department of Agriculture. Leaflet No. 380: The Wheat Jointworm: How to Fight it. Pp. 8. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [72]

Trinidad and Tobago. Forest Department. Annual Administrative Report for the year 1953. Pp. 31. (Port-of-Spain, Trinidad: Forest Department, 1954.) [72]

Sveriges Geologiska Undersökning. Ser. C. No. 530: Kvartärgeologiska Studier inom Rönneåns Dalbäcken i Nordvästra Skåne. Av Helge Tullström. Pp. 73+2 plates. 3 kronor. Ser. C. No. 535: Die Mollusken und Brachiopoden der Schwedischen Kreide. 4: Die Mammilliten- und Nuculanenkreide des Västadsgebietes. Von Richard Hägg. Pp. 72+9 plates. 3 kronor. Ser. C. No. 536: A Telluride Assemblage in the Rautbäckens Pyrite Ore. Vesterbotten, N. Sweden. By Sven Gavelin. Pp. 14. 1 kronor. Ser. C. No. 537: Undersökning rörande Spridning och Avstötning av i Vattnet Suspenderat Slam vid Utstjälpning av Muddar i Byfjorden Vären 1953. Av Jerlov och B. Kullenberg. Pp. 26. 2 kronor. Arsbetättelse för År 1953. Pp. 8. (Stockholm: Kungl. Boktryckeriet, P.A. Norstedt och Söner, 1954.) [212]

Det Kongelige Industri-, Håndverk- og Skipsfartsdepartement. Norsk Polarinstitut. Skrifter Nr. 96: Geochemical Affinities of Some Coals from Svalbard. By J. B. Butler. Pp. 26. 3 kronor. Skrifter Nr. 98: The Barnacle *Balanus balanoides* (Linné, 1760) in Spitsbergen. By Rolf W. Feyling-Hanssen. Pp. 64+9 plates. 8 kronor. (Oslo: I Kommissjon hos Brøgers Boktrykkeris Forlag, 1953.) [212]

Editorial and Publishing Offices of "NATURE"

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831. Telegrams: Phisus Lesquare London

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1

Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

REPORTS and other PUBLICATIONS

(not included in the monthly Book+ Supplement)

Great Britain and Ireland

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1953-54. West Indies. By J. V. Lochrie, J. R. Spence and C. T. Cave. Pp. 19. 9d. Nyasaland. By H. C. Ducker. Pp. 9. 9d. (London: Empire Cotton Growing Corporation, 1954.) [72]

National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1953 to 30th June, 1954. Pp. 20. (London: H.M. Stationery Office, 1955.) 9d. net [72]

Short Course of German Reading for Students. By Dr. W. F. Jepson. Pp. 8. (Sunninghill: W. F. Jepson, 1954. Obtainable from H. K. Lewis and Co. Ltd., London, W.C.1.) 1s. 6d. [72]

The Registrar General's Statistical Review of England and Wales for the year 1951. Text volume. Pp. xiii+312. (London: H.M. Stationery Office, 1954.) 10s. net. [72]

Orthoide Wetttable 50% Capitan. Report of Trials conducted in Great Britain and Ireland during 1954. Second edition, January 1955. Pp. 32+12 tables. (Wheatthampstead: Murphy Chemical Company, Ltd., 1955.) [72]

Regional Advisory Council for Higher Technological Education: London and Home Counties. Sixth Annual Report, 1953-54. Pp. 40. (London: Regional Advisory Council for Higher Technological Education, 1955.) [72]

National Coal Board: Scientific Department. Science Bulletin—Autumn, 1954 (No. 3). Pp. 15. (London: National Coal Board, 1954.) [72]

Shell Photographic Catalogue. 132 pages of additions to Volumes 4 and 5. (London: Shell Petroleum Co., Ltd.) [72]

Sperry Synchro Design—Theory—Application Pp. 72. (Publication 652.) (Brentford, Middx.: Sperry Gyroscope Co., Ltd., 1954.) [72]

The Partnership of Science and Engineering. By Sir Edward Appleton. (Twenty-third Andrew Laing Lecture, delivered before the North East Coast Institution of Engineers and Shipbuilders, in Newcastle upon Tyne on the 10th December, 1954.) Pp. ii+10. (Newcastle upon Tyne: North East Coast Institution of Engineers and Shipbuilders; London: H. and F. N. Spon, Ltd., 1955.) 3s. 6d. [72]

Colonial Office. Colonial Development and Welfare Acts. Report on the administration and use of the Funds provided under the Colonial Development and Welfare Acts. Pp. 32. (Cmd. 9375) (London: H.M. Stationery Office, 1955.) 1s. net. [152]

Ministry of Agriculture and Fisheries. Department of Agriculture for Scotland. Myxomatosis: Second Report of the Advisory Committee on Myxomatosis. Pp. ii+6+1 map. (London: H.M. Stationery Office, 1955.) 1s. net. [152]

NATURE

No. 4461

SATURDAY, APRIL 30, 1955

Vol. 175

CONTENTS

	Page
Man-power and Resources in Defence Policy	739
Current Progress in Psychical Research. By Dr. E. J. Dingwall	741
Molecular Structure. By Prof. C. A. Coulson, F.R.S.	741
Chemical Lecture Experiments by Screen Projection. By G. Fowles	742
Oil in the U.S.S.R. By H. B. Milner	742
The 15-MeV. Linear Accelerator at St. Bartholomew's Hospital. By Prof. J. Rotblat	745
Relaxation and Flow in Glasses	747
Project 'Shower': an Investigation on Warm Rain in the Hawaiian Islands. By P. Squires	748
Obituaries :	
Mr. J. F. Didusch. By Dr. George W. Corner	750
Mr. W. R. Sherrin. By Dr. J. Ramsbottom, O.B.E.	750
News and Views	751
British Society of Animal Production, 1944-54. By Prof. J. E. Nichols	756
Berlin Academy of Sciences. By Dr. W. A. Wooster	757
National Science Foundation, Washington, D.C.: Report for 1953-54	757
Natural Permanent Magnetization of the Lower Basalts of Northern Ireland	759
Time-scale of the Universe	759
Effect of Inclusions on Steel. By Prof. F. C. Thompson	760
Standardization of Wound Textiles. By Dr. Heinz Baron	760
Artificial Production of Immunological Tolerance. By Dr. Morten Simonsen ; Dr. M. Hasek and Dr. T. Hrabá	763
Letters to the Editors :	
Crystal Structure of Benzene : a New Type of Systematic Error in Precision X-Ray Crystal Analysis.—Prof. E. G. Cox, F.R.S., Dr. D. W. J. Cruickshank and Dr. J. A. S. Smith	766
The Serpent Spring.—Prof. R. Tomaschek	766
A Slip-band Exudation Effect observed in Pure Aluminium.—P. J. E. Forsyth and C. A. S. Stubbington	767
Vapour Circulating Pumps.—A. H. Cockett	768
Radioactivation Analysis of Arsenic in Silicon.—J. A. James and D. H. Richards	769
Dye-sensitized Photopolymerization of Styrene.—M. Koizumi, A. Watanabe and Z. Kuroda	770
Mechanism of the Acid Hydrolysis of Glycylglycine.—Dr. R. J. L. Martin	771
Reactions between Quinones and Proteins.—Dr. H. S. Mason	771
Chromatography of Phospholipids.—Dr. F. D. Collins and L. W. Wheeldon	772
Muscle Sodium.—Prof. E. J. Conway, F.R.S., and Mary J. Carey	773
Total and 'Exchangeable' Potassium in Humans.—Dr. J. Rundo and Dr. U. Sagild	774
Distribution and Formation of Isocitritase.—Roberts A. Smith and Dr. I. C. Gunsalus	774
Concentration of Iodine-131 across the Placenta of the Guinea Pig and the Rabbit.—Dr. J. Logothetopoulos and R. F. Scott	775
Urinary Excretion of a Substance after a Single Dose.—J. Hough, Dr. H. Barnard and O. Bassir ; Babette E. Stern	776
The Binding of Vitamin B ₁₂ by Castle's Intrinsic Factor.—Dr. Laureen Raine	777
Effect of Splenectomy on 'Antrycide' Therapy of <i>Trypanosoma evansi</i> Infection in Rats.—H. G. Sen, B. N. Dutta and H. N. Ray	778
Resistance to Colicin E as a Genetic Marker in <i>E. coli</i> K12.—C. R. Jenkin and D. Rowley	779
A <i>Limax-Amoeba</i> from the Rectum of the Grass Snake, <i>Natrix natrix</i> , as a Facultative Aerobe <i>in vitro</i> .—Dr. R. S. J. Hawes	779
Use of Liquid Propane as Refrigerant.—A. H. Cockett	780
Recent Scientific and Technical Books	Supp. vi

Editorial and Publishing Offices of Nature

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1

Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office



CULTURE MEDIA FOR FUNGI

This group of Dehydrated Culture Media, Difco, is prepared expressly for propagation of the fungi most frequently encountered in phytopathological studies. Each medium is readily prepared for use and requires no adjustment of its reaction or filtration of the solution.

Bacto-Bean Pod Agar

Bacto-Corn Meal Agar

Bacto-Lima Bean Agar

Bacto-Malt Agar

Bacto-Potato Dextrose Agar

Bacto-Prune Agar

Bacto-Wort Agar

Bacto-Malt Extract Broth

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

in the Research and Development of Bacto-Peptone and Dehydrated Culture Media

Sole Agents for Gt. Britain

BAIRD & TATLOCK (LONDON) LTD.

FRESHWATER ROAD, CHADWELL HEATH, ESSEX

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

*World's Largest Stockists
of Scientific Periodicals*

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading
Universities, Public Libraries
and Institutions of the World.
Catalogues issued.

SELLING?

Specialists in Scientific,
Technical Books and
Publications of all
Learned Societies.

Why not consult us first?

102 WIGMORE STREET, LONDON, W.1

Telephone: Wel. 4948; Amb. 5991

The Chemistry of Micro-Organisms

By ARTHUR BRACKEN, B.Sc., Ph.D., F.R.I.C.

This is a work for organic chemists, microbiologists and degree students which gives a fully documented account of the chemical changes produced by micro-organisms. The role of micro-organisms in the isolation of new substances, e.g., the antibiotics, and consequent developments in chemistry, biochemistry and medicine, are reviewed. 30s. net.

PITMAN

Parker St. Kingsway London, W.C.2

MAN-POWER AND RESOURCES IN DEFENCE POLICY

THERE was little evidence in the debates in Parliament on March 1 and 2 that the critical importance of science in defence is clearly appreciated by politicians. The references by Mr. Martin Lindsay and Lord Templewood and Lord De L'Isle and Dudley to the chronic shortage of skilled men, technicians, technologists and scientists in the radio-engineering and aircraft industries were perhaps the clearest indication in the debate that defence policy is ultimately conditioned by our resources of trained man-power and the disposition of those resources to the best advantage. On that the recent Statement on Defence* gives little guidance. It refers to the problems which the threat of nuclear attack presents to the air defence forces of Britain, to the further increase in the proportion of all-weather radar-equipped fighters and the high priority which continues to be given to the development of guided missiles, to the increased need for flexibility imposed on land forces so as to be able to move from dispersion to concentration as quickly, and with as little confusion, as possible, and to the greater elasticity of outlook required by commands at all levels and the modification in organization and equipment of fighting units. It is taken for granted, however, that all this and the transformation and re-equipment of the Navy with nuclear and with guided weapons are tasks well within the scientific and technical resources of Britain without overstraining the economy of the country.

"Within the limits of our resources . . . we are planning for a better-equipped and maintained Active Fleet and a reduced but much more highly prepared Reserve Fleet; a smaller, better disposed, more mobile Army; and a more powerful Air Force including, in particular, an effective strategic bomber force." All these forces are to be armed with the most modern weapons, and while there is reason for believing that thermonuclear weapons need not prove quite so costly as the original prototypes, there is no indication in the White Paper of technical factors which would permit the cost of defence to be pruned. In fact, on the man-power situation it is disquieting, and the section on research and development is far from providing an adequate basis for informed discussion.

In regard to man-power, it is apparent that the Services are already finding it difficult to recruit adequate numbers of long-service men of the standard required; and the defence debates, notably that in the House of Lords, showed that this is a question which touches very closely the supply of scientists and technicians in general. As Lord Templewood pointed out, the Services have a continuing problem of recruiting the scientists and technicians they need in competition with industry. This cannot be dismissed

as a temporary problem, and long-term solutions are no more likely to arise out of palliatives than the shortage of science teachers in schools—with which it is related—will be removed by piecemeal and patchwork measures.

The need for overall consideration of the demands made on the scientific resources of Britain, and especially in man-power, applies even more clearly in the section of the White Paper which discusses research and development. These are notably affected by the decision to base defence policy primarily on the maintenance of the nuclear deterrent to aggression. The research and development programme as a whole has recently been fully reviewed in the light of this decision; but it is still necessary for Britain to continue with the development of other weapons. Many of the projects on which Britain is expending much effort are as yet unproved, and with so much at stake it would be wrong prematurely to abandon all other lines of development. Moreover it is still true (and of other countries as well as of the United Kingdom) that the time taken to put the new types of weapons through all the various stages of research and development into production tends to be very much longer than in the past.

The British organization for defence research and development has been stated authoritatively to compare well with that of the United States, for example, but that is no reason for complacency. The range of effort barely recapitulated in the White Paper might well prompt the disquiet evinced in the defence debates, notably in that on the Air Estimates in the House of Commons, when Mr. C. I. Orr-Ewing and Mr. Paul Williams suggested that the present and increasing shortage of skilled technicians in industry, for research and as science teachers in the schools is the Achilles heel of the defence programme and of economic development in the United Kingdom and the Commonwealth. The White Paper gives no indication of the demand for man-power which the programme of research and development involves; nor is the exact expenditure for that purpose to be discovered. Lord Alexander of Hillsborough suggested it might be of the order of £160-180 million, and asked how the actual research cost is allocated and its distribution between the Services concerned.

Little information was forthcoming in the debates to remove the misgivings evinced both in the House of Lords and the House of Commons; what is clearly required is an indication that the research effort is being planned with due regard to the country's scientific and technical resources. Neither the debates nor the White Paper dispelled the concern that Britain may be attempting too much with limited resources, and that our contribution to Western defence as well as to that of the United Kingdom and the Commonwealth might be more effective if we concentrated our effort on carefully chosen, but

* Statement on Defence, 1955. Pp. 30. (Cmd. 939.) (London: H.M. Stationery Office, 1955.) 1s. net.

more limited, objectives. The White Paper, for example, refers to the close collaboration which exists with the United States in the field of guided weapons. Comprehensive arrangements have been made for the exchange of information and of visits by technical personnel. Nevertheless, Parliament was far from being satisfied that everything possible is being done to eliminate duplication of effort and to exchange information. In the debate on the Navy Estimates, for example, reference was made to the importance of exchanging information on research on hydrofoil boats not only with the United States but also with Europe.

This point has been pressed repeatedly in the House of Commons recently, particularly in respect of the exchange of information on thermonuclear weapons and on the effect of radiation resulting from the explosion of nuclear weapons. Mr. H. A. Nutting stated on March 14 that we are at present in touch with the United States Government as to the possibility of concluding a bilateral agreement on the exchange of information generally under the United States Atomic Energy Act, 1954; but Mr. J. Grimond was right to emphasize the present concern in Britain as to the lack of co-operation over thermonuclear and other forms of weapons in the armament programme. None of this is covered by the United States Atomic Energy Act of 1954: the McMahon Act still restrains the exchange of information on the theory, design and manufacture of nuclear weapons. The interest taken in Sir William Penney's recent visit arises largely from the hope that it may lead to some initiative in this direction from the United States side, or at least lead the United States to doubt the wisdom of restrictions which encourage waste where co-operation could be most fruitful to both sides.

Britain must, of course, have something to offer; but no doubts need be entertained on that score so long as the country's efforts are not dispersed too widely. These problems, however, scarcely received the attention they demand in the defence debates, and with the general acceptance of the main basis of the Government's defence policy, it is essential that its technical, as well as its political, implications should be clearly understood and constructively criticized. This is the more important in that the Government made no attempt in the defence debates to meet a number of points raised, and also in view of the evidence in the Statement on Defence and in the replies to questions as to the radiation effects of nuclear explosions that the Government is scarcely giving sufficient attention to the matter of co-operation. The Statement has indeed a section on "Co-operation within the Commonwealth and with International Organisations", but no reference is made in it to the importance of preventing duplication of research, and the cost of security is sometimes confused with that of independence.

That is true of other countries as well as Great Britain and the United States; but even Anglo-American co-operation is not facilitated by political party bickerings, or the disposition to make party capital out of what are essentially technical issues.

In pressing for the maximum possible co-operation in defence research and development, it should be remembered that evidence of united purpose and continuity of policy are powerful factors in attracting the response that co-operation implies. It is quite clear that those who, like Lord Winster, asked in the debate whether we could undertake the manufacture of thermonuclear weapons without dropping something else, did so in no party spirit; and the question, like those regarding scientific and technical manpower, deserved a fuller answer than it received from Government spokesmen in either House.

Next to the over-riding importance of full co-operation with our partners in Western defence, especially in thermonuclear weapons, the White Paper and the debates on defence demonstrate the critical importance of scientific and technical manpower. Short-term expedients to meet particular sudden emergencies are no substitute for a considered policy which will ensure that a steady and continuous supply of men and women of the requisite calibre is available where they are needed. To achieve this without untoward effects on other sectors of the national economy and without disturbing the flow of new knowledge upon which defence, no less than industrial advance, depends, demands foresight and imaginative planning, as well as a large measure of co-operation from the universities and educational authorities, government departments and industry as well as public corporations and research institutions. It is a matter of the wise use of scientific and technical manpower as well as of training and distribution and only a considered policy will avoid recourse to methods of distribution which could well do more harm than good.

Such a policy can only be expected when the Government shows a real appreciation of the importance of science and technology and their bearing on defence, industrial development and public welfare in general, and is prepared to shape policy accordingly and to provide the organization and means by which science and technology can be most effectively applied to the national purpose. Once again the Government singularly failed to provide in the defence debates any evidence that it understands the importance of science and technology even in defence, or that the success of the policy laid down in the White Paper ultimately depends on whether Britain possesses resources in scientific and technical manpower to implement the programme outlined. On this vital question, both the Lord President of the Council, generally regarded as the responsible head of the national effort in scientific research, and the Minister of Defence, were silent. Clearly the time is ripe for reconsideration of the whole organization by which the nation's limited resources in science and technology, both in men and materials, are brought to bear most fruitfully and effectively on the objectives which defence policy and national welfare demand. Constructive thinking here would facilitate sound answers to the many important questions which Government spokesmen have so far parried.

CURRENT PROGRESS IN PSYCHICAL RESEARCH

Modern Experiments in Telepathy

By Dr. S. G. Soal and F. Bateman. Pp. xv+425+3 plates. (London: Faber and Faber, Ltd., 1954.) 30s. net.

A New Approach to Psychical Research

By Antony Flew. Pp. viii+161. (London: C. A. Watts and Co., Ltd., 1953.) 10s. 6d. net.

Psychical Research Today

By D. J. West. Pp. 144+8 plates. (London: Gerald Duckworth and Co., Ltd., 1954.) 12s. 6d. net.

THESE three books on modern progress in psychical research are a fair indication of what students are doing and thinking in this hotly debated field. In the first of them, by Dr. S. G. Soal and Mr. F. Bateman, the authors have given us by far the most important work on extra-sensory perception that has hitherto appeared. Not only do they present an admirably documented and critical survey of most of the experimental work in the past; but here also will be found in convenient form a full and detailed account of the famous series of card-guessing tests with the two most outstanding British subjects, Mr. Basil Shackleton and Mrs. Gloria Stewart. On reading these records, it is clear that, by their insistence on the most rigid experimental technique, the authors have shown that work in this field can be carried out and brought to fruition as in other branches of science.

Owing to the apparent scarcity of good subjects, much laborious work has to be undertaken with results that, in the end, are wholly without significance. The same precautions, however, have to be observed in every case and the same careful scrutiny of the completed scores. It was only after ten years of such trials that Dr. Soal was fortunate enough to meet his two subjects who, after repeated tests, showed a consistently high rate of scoring which continued after, it would seem, every conceivable precaution had been taken. It is this consistency, coupled with the results of sudden changes in the technique, that makes the theory that extra-sensory perception is something of the nature of a statistical artefact very difficult to sustain.

In the early chapters a short survey of the work from 1883 is attempted; but chief attention is rightly given to those series where statistical evaluation of the results was achieved. They show how various sources of error were detected, met and eventually eliminated; how attempts were made to correlate extra-sensory perception with personality ratings, and how Carington's claims for the validity of his results in matching drawings cannot be justified unless an intensive inquiry into common preferences of varied cross-sections of the population has been carried out.

In the present volume, the authors have made but little attempt to discuss their results from the point of view of the psychologist or the philosopher. Such was not their intention. Their aim was to describe and evaluate experimental work, and not to deal with any implications in relation to other fields of inquiry. It is here that Prof. Antony Flew's little book on the connexion between psychical research and philosophy fills the gap. After a brief account of the subject-matter of his thesis, he goes on to discuss the meaning of many of the phenomena reported,

and stresses the difficulty of dealing with a subject where so much out-moded terminology abounds. He believes an approach must be made towards revising these linguistic pitfalls, and that some new terminology should be adopted which is theoretically neutral and not liable to cause so many logical and philosophical perplexities. Believing as he does that extra-sensory perception is a fact, Prof. Flew is at pains to point out that our knowledge of it is so meagre that great care should be exercised lest, by faulty linguistic description, false ideas may be engendered. He maintains, indeed, that almost all the terms in current use are radically unsatisfactory; and in pointing the way to a new nomenclature he directs the attention of psychologists and philosophers to those phenomena which are more and more engaging the serious consideration of experimenters in this field. How varied are these phenomena and with what caution they have to be treated is set out in concise fashion in Dr. D. J. West's account of psychical research as seen to-day.

It is clear that, in this well-documented and objective survey of the present situation, the author is well acquainted with modern tendencies and the strength and weakness of many of the cases he discusses. Generally speaking, he is inclined to be cautious, and it may come as a surprise to some to find that he regards the evidence for the spontaneous cases such as apparitions as well as various types of veridical hallucinations as far less cogent than has hitherto been supposed.

In his treatment of mental mediumship, the physical phenomena, hauntings and poltergeists, Dr. West is restrained and critical; and it is only when he treats of progress in work on extra-sensory perception that he shows much enthusiasm. For it is his opinion that, apart from extra-sensory perception and possibly some form of precognition, all is controversy and speculation. In recognizing that extra-sensory perception itself cannot be explained upon any physical basis, he joins hands with Prof. Flew in laying stress on the harm that a faulty nomenclature may have on our ideas. As Dr. West concludes, the subject is one big question mark; but he hastens to add that it is remarkable that research has gone so far as it has. For those who wish to become better acquainted with that research, to learn how it is conducted and what may be some of its implications, then these three books are to be recommended. They are some of the most important contributions to the subject that have appeared within the past five years.

E. J. DINGWALL

MOLECULAR STRUCTURE

An Advanced Treatise on Physical Chemistry

By Prof. J. R. Partington. Vol. 5: Molecular Spectra and Structure, Dielectrics and Dipole Moments. Pp. x+565. (London: Longmans, Green and Co., Ltd., 1954.) 80s. net.

THE latest instalment of Prof. J. R. Partington's prodigious treatise fills the reader with no less astonishment than did its four predecessors. Anyone who reflects on the enormous effort needed to write what are effectively the two text-books which comprise this particular volume will want to congratulate the author. His lucidity, his breath-taking comprehensiveness and his historical sense, already commented on in reviews of the earlier volumes, are

no less evident in this. Chemists in general will be interested to learn that there are more than four thousand distinct literature references, many of them going back up to a hundred years; and, of these, nearly one-third are to American workers, and one-quarter each to British and German.

In a treatise of this kind, some sort of selection has to be made from all the material available; and in such a selection everyone will be disappointed somewhere or other. In the section on molecules the account of molecular structure is quite good, though it does not do sufficient justice to the concept of hybridization; but the account of molecular spectra is, by contrast, very thin, ionization potentials being scarcely mentioned and Rydberg series entirely omitted. In the same way there will be many who will regret that nothing is said about the concept of co-operative phenomena in the chapter on dielectrics.

Prof. Partington is most anxious that no one should fail to understand his analysis through insufficient knowledge of mathematics. So everything which is needed is fully developed. The result is uneven: there is the proof of the relation between the three moments of inertia for a plane lamina ($I_x + I_y = I_z$); and there are also sixty solid pages of formulae and analysis connected with spherical harmonics. Perhaps some of this latter may be used in later volumes: certainly not much of it was needed in this, and much of it is considerably more advanced than is the formula for moments of inertia.

When I had finished reading this book, I could not help wondering whether a task of this immensity is really possible for one person. For the subject-matter is too diverse for any person, however learned, however versatile, however patient—and Prof. Partington has all three of these qualities. It is inevitable that there should be mistakes. I found seven or eight quite serious ones, varying from the assertion that the spins of the two 3s electrons in magnesium could be either parallel or anti-parallel, to the remark that under certain conditions the molecule H_2 could be raised to a higher rotational level of 3.54 eV. Quite apart from the lack of balance that was referred to earlier, these mistakes do detract from the reliability and trustworthiness of the book. I should not wish to let it fall into the hands of an unsuspecting undergraduate. But research students and intelligent undergraduates who have been forewarned will find it a mine of information, and will rejoice at the simple unaffected style and the sound historical feeling which are so evident within its pages.

C. A. COULSON

microprojectors and other apparatus, and here and there suitable experiments, have appeared in journals devoted to science teaching. Prof. E. J. Hartung, professor of chemistry in the University of Melbourne, has now prepared a thorough and systematic account of the requisite apparatus, techniques and experiments.

He devotes his first six chapters as follows: general principles of projection optics; description of equipment, including, among other items, light sources, cooling devices, lenses, mirrors, prisms, screens, projection microscopes, polarizing apparatus, diascopes and universal projectors; arrangement of the lecture room; and general notes on the actual technique of demonstration. The headings of his last eleven chapters are also those of the classes into which for convenience of treatment he has divided the two hundred and fifty experiments he describes. He gives full directions for carrying out each of these experiments and suggests the most suitable type of projection.

Experiments, notably those illustrating the Brownian movement, anisotropy and enantiotropy, lend themselves admirably to screen projection and, with economy of time, cannot be effectively shown to a large class in any other way. Prof. Hartung's selection includes many of the above class and, among other exceedingly good ones, some leading to an understanding of selective adsorption and illustrating differential flotation.

Mingled with these excellent illustrations are numerous simple reactions illustrative of elementary chemistry, such as the acidity of soda water, the interaction of carbon dioxide and lime water, the displacement of lead by zinc, the action of ammonia on copper salts, and so on, reactions which students can readily carry out by themselves, and which few teachers would call lecture experiments. I admit that by screen projection are revealed some phenomena, such as the streaming of invisible gases, which are not seen in the ordinary way of experimenting; nevertheless, I consider that the author has done his book a disservice by including so many experiments of the above class, for he thus makes his instruction entirely informative and gives no scope for the investigative spirit. Be that as it may, the teacher himself from the abundance herein given can select which experiments to screen, and all who desire to support their discourses with striking and beautiful illustrations should make themselves acquainted with this book.

G. FOWLES

CHEMICAL LECTURE EXPERIMENTS BY SCREEN PROJECTION

The Screen Projection of Chemical Experiments

By Prof. E. J. Hartung. Pp. xiv + 291. (Melbourne: At the University Press; London: Cambridge University Press, 1953.) 30s. net.

THE literature of chemical lecture experiments is not extensive, and the addition to it of a book on a novel and special branch is welcome. Modern projection apparatus and technique permit small-scale experiments to be made easily visible to a class. A number of schools in Great Britain have for years used such aids, and descriptions of home-made

OIL IN THE U.S.S.R.

Oil in the Soviet Union

History—Geography—Problems. By Dr. Heinrich Hassmann. (Translated from the German with the addition of much new information by Alfred M. Leeston.) Pp. xvi + 173. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1953.) 3.75 dollars; 30s. net.

THE Russian way of life and the philosophy of Bolshevism may be enigmatical to Western peoples, but at least her economic and political activities in their external impacts may be scrutinized objectively; in particular, her oil industry can be described and assessed at its present level. To comprehend past developments of the Russian petroleum industry and

present trends, and to anticipate future hopes and achievements, demand at the outset a clear picture of the enormous territory involved in the Soviet Union, approximately nine million square miles or three times the size of the United States. With this are involved considerations of history, population, constitution and economics, each of which is convincingly portrayed by Dr. H. Hassmann in this book as the background to the main theme. The existing political setting necessarily features in the book, especially as it affects the economic system; but commendable effort has been made to avoid military or ideological implications, and also indulgence in what might be called 'wishful oil thinking'.

To students of oil technology, "Eternal Fire of Surakhany" ranks with many other actual and mythical indications of petroleum chronicled by the ancients, as a chapter in the genesis of the industry itself. Baku has remained classic not only throughout Czarist times but also under the existing Soviet regime. Fields such as Baku, Grozny, Maykop, Emba, Cheleken, Sabunchi, Balakhany, Romany and Bibi-Eybat individually achieved through the years international fame, both for geological and production reasons; early in this century the Binagady and Surakhany oilfields added their quota to this highly concentrated, unique Apsheron Peninsula; now, as then, this Peninsula is of prime importance in Russian oil developments.

In the present scheme of things, the State is both owner and operator of the industry. From initial geological and geophysical surveys, through the long sequence of drilling, production, refining, transport and distribution of petroleum and its products, the State is the authority. In it is further vested supply and control of man-power, working conditions and all finances, the latter embracing not only costs of production but also prices of finished products. The oil industry in this perspective is thus seen as an integral part, a vitally important one, of the whole economic system of the U.S.S.R. In actual practice, oilfields and oil plants are merged as individual 'trusts'; these in turn are combined into larger groups, the latter under direct control of the Federal Ministry of Petroleum Production with a Minister at its head. Thus Soviet oil to-day revolves around eight indigenous groups: Azneft (Baku); Grozneft (North Caucasus); Krasnodarneft (Northwest Caucasus); Kuybyshevneft (Ural-Volga); Molotovneft (Ural-Volga); Bashneft (Ural-Volga); Kazakhstanneft (Emba); and Sredasneft (Central Asia). In addition, there are several trusts under the direct control of the Ministry—for example, Dagneft in Dagestan, and Sakhalinneft on Sakhalin Island.

In so far as statistics provide supporting evidence of modern developments of Russian oil, important facts to be deduced from data given in this volume are certainly illuminating. "Russia is one of the world's most important oil countries!", it is stated. Figures of crude oil production quoted show that, at least from 1948 until 1952 inclusive, the U.S.S.R. stood third in world order, the United States and Venezuela being first and second respectively. One of the most significant sections of this book (Part 2) reveals how this position has been consolidated, judged on a purely technical basis. Up to 1946 all exploratory work for petroleum in the Union was controlled by the Chief Administration for Geology and Geodesy of the Supreme Economic Council, which then became the Ministry of Geology,

with the task of co-ordinating all geological work for the discovery and recovery of the rich mineral resources of the Soviet Union. In this context the statement that by "the planned co-operation of the state, the economy, and science, three quarters of the entire area of the Soviet Union had been geologically explored up to 1947" is somewhat surprising. It is estimated that more than one thousand geological-geophysical prospecting units, well equipped, are working in exploration of mineral resources (including petroleum), particularly in the central and peripheral regions of the Union. Considering the enormous size of territory involved, the programme ahead, even allowing for what has already been accomplished, must be a staggering problem for the Ministry concerned; one would have thought that considerably more than one-quarter of the Union awaited pioneer developments, especially in eastern provinces and more northerly latitudes.

This is not the only problem, however. The author is concerned with the future oil demand of the Soviet Union and states his conclusion that "Russian oil supply is the Achilles' heel of the Soviet economy". From this stem arguments that indigenous oil supplies have not risen as rapidly as production in the United States and elsewhere in the world, nor even with demands of Soviet industrial production; that imports of oil from countries within the orbit of the political and economic influence of the U.S.S.R., because of their individual demands, cannot make up a major leeway. Sinkiang, the East Chinese province, is a potential external source, dependent on positive economic developments foreshadowed in the Russo-Chinese treaty of 1950; but results of this exploratory work in terms of direct exports of oil from this source to the U.S.S.R. are, so far as is at present known, vague. Thus, "the core of the Soviet oil industry will always be the Russian oil fields", a conclusion leading to a searching epilogue to this seemingly well-informed book.

So inevitably, as others have done before him, Dr. Hassmann detaches his theme from the U.S.S.R. and translates the economies he has been at such pains to expose via "Alpine regions of world politics" into the unpredictable future of Middle East oil production. Iran, Iraq, Saudi Arabia, Kuwait, Qatar and Bahrain Island—herein concentrated are estimated to lie more than 40 per cent of the total world oil reserves: a fabulous oil area on the threshold of the U.S.S.R. The author leaves the reader in no uncertain doubt of his interpretation of the issues at stake. If circumstances should ever place Middle East oil (believed to be capable of exceeding one hundred million tons in a matter of years) under Soviet control, then this colossal increment to her indigenous production implies such increase in economic power of the U.S.S.R. as would shake the whole world political situation. However, at this point, we may profitably return to the foreword, wherein that eminent petroleum technologist, E. de Golyer, joins issue. Just as the Middle East is vulnerable to military attack, de Golyer argues, so is the Baku region, the chief present source of Russian oil. "Clearly the strategy of the Soviet Union calls for the building up of a less vulnerable source of supply in the interior of Russia, and to this end the Soviets appear to be concentrating their efforts". Whichever way one contemplates the situation and whatever the future may unfold in fields of nuclear energy, petroleum is still a major force in power politics.

H. B. MELNER

Witchcraft Today

By Gerald B. Gardner. Pp. 163+4 plates. (London: Rider and Company, 1954.) 12s. 6d. net.

THIS interesting and unusual book appears to be the first of its kind. Written by Dr. G. B. Gardner, the director of the Museum of Magic and Witchcraft in the Isle of Man and a member of one of the few covens of the witch cult left in Britain, it sets out to describe how the practices of modern witchcraft are connected with the ancient rites and how they may be compared with the revelations concerning them which were brought to light in the witchcraft trials. Dr. Gardner writes with a disarming simplicity. He shows himself perfectly aware of the difficulties, the contradictions and the apparent absurdities of witchcraft as it is generally understood. Yet, as Dr. Margaret Murray indicates in her admirable introduction to the book, much remains of great interest and psychological importance. The rhythmic movements and chants in which numbers of persons take part induce both exhilaration and at times even a kind of intoxication, during which gratitude is extended to the Creator for his goodness and hope is expressed for its continuance.

Far from deriding the existence of the witch 'power', Dr. Gardner is at pains to link it up with what is known about suggestion, extra-sensory perception and even radiesthesia. In the course of his discussion he shows clearly where the pitfalls lie and, while expressing his own tentative views on these controversial matters, never irritates the reader by propaganda designed to convert him to unreasoning belief. The book is well produced with a useful list of references; but unfortunately there is no index. It is to be recommended to all who wish to learn something of the meaning of witchcraft as it is to be understood to-day and interpreted through the help of modern followers of the cult. E. J. DINGWALL

Encyclopedia of Chemical Reactions

Compiled and edited by C. A. Jacobson, with the assistance of Clifford A. Hampel and Elbert C. Weaver. Vol. 5: Nickel, Niobium, Nitrogen, Osmium, Oxygen, Palladium, Phosphorus, Platinum, Potassium, Praseodymium, Radium, Rhenium, Rhodium, Rubidium, Ruthenium. Pp. viii+787. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 120s. net.

THE fifth volume of this encyclopædia follows the same pattern as that of previous volumes. It covers, in alphabetical order, all the elements from nickel to ruthenium excepting protoactinium and radon. Actually, only a few reactions are listed for radium, rhenium and niobium. The inclusion of niobium seems unfortunate considering that a larger number of its reactions have already been listed under columbium. Like some of the earlier volumes, the present one gives the same impression of untidy carelessness and poor editing. For example, the few reactions given under rhenium are all taken from a published lecture and no reference is made to the actual discoverers of the reactions; the impression is therefore given that the lecturer is the originator of the reactions. There is also some carelessness in regard to nomenclature, as, for example, when $(\text{PNCI}_2)_3$ in one abstract is called phosphorus chloronitride, while in the next it is phosphorus dichloride nitride; $(\text{PNCI}_2)_4$ is given the more workman-like name of tetraphosphonitrilic chloride. In addition, there are a number of printing errors.

Although this encyclopædia is extremely useful, one does feel that its value would have been greater if, instead of the haphazard abstraction of chemical reactions from any journal which happened to be handy, a directed and determined effort had been made to provide a reasonably complete list of the reactions of the various elements.

G. R. DAVIES

Metallurgical Abstracts

General and Non-Ferrous. Volume 20, 1952-53 (New Series). Edited by N. B. Vaughan. Pp. iv+602. (London: Institute of Metals, 1953.) 60s.

THE service offered by the well-known "Metallurgical Abstracts" is outstanding. For a modest sum a bird's-eye view, as it were, of world progress in a large part of metallurgical science and practice is provided. The specific scope cannot be defined with precision in a few words, but broadly it consists of the general theory of the metallic state and the science and practice of non-ferrous metallurgy (excluding mining and extraction), together with many associated subjects.

The abstracts are informative rather than merely indicative, which is a great advantage especially with foreign publications, although it naturally involves greater delay in publication than with the indicative kind. The reviewer can testify, from personal use, to the general reliability of the abstracting. There are twenty-three subject headings, and this is generally satisfactory, except for physical metallurgy, the bulk of which subject is found under three headings; these are too few, and considerable work could be avoided for users if more subdivisions were used. The matter is presented in good print on very suitable paper, and is thoroughly indexed with respect to names and subjects. A. R. BAILEY

Exercises in Theoretical Statistics

With Answers and Hints on Solutions. By Prof. M. G. Kendall. (London: Charles Griffin and Co. Ltd., 1954.) 20s.

THIS collection contains four hundred exercises taken mainly from examination papers at research journals, and it represents yet another example of the prodigious labours of Prof. M. G. Kendall, for which statisticians have already much reason to be grateful. He has not attempted to cover all the applications of statistics, but has concentrated on basic theory, dividing the exercises into five groups, namely, distribution theory (100 exercises), sampling theory (100), relationship (75), estimation and inference (75) and times series (50). Not all will agree with the classification he has employed; in particular, the line of demarcation between the first two groups is rather indefinite while exercises on the evaluation of moments appear in all groups. Because of the close integrative relationship between courses of lectures and the examination questions to which they lead, published examination papers tend to look even harder to others than they did to their intended recipients. Thus, the student working on his own would gain little help from standard texts in attempting, for example, the elegant series of problems on the theory of queues for which Cambridge 1948 was such a vintage year. Prof. Kendall has now largely overcome this difficulty by the outline solutions at the end of the book, which make it valuable to student and teacher alike.

R. L. PLACKETT

THE 15-MeV. LINEAR ACCELERATOR AT ST. BARTHOLOMEW'S HOSPITAL

By PROF. J. ROTBLAT

AN electron linear accelerator has recently been completed by the Mullard Research Laboratories and installed in a temporary building adjacent to the Physics Department of the Medical College of St. Bartholomew's Hospital, London. The accelerator, which was purchased from the Hospital Discretionary Fund, will ultimately be employed for treatment; but during the next few years it will be used entirely for research work in fundamental studies on the action of radiations on living tissue, on new techniques in radiotherapy, and on some problems in nuclear physics.

The accelerator is of the travelling-wave type. It consists essentially of two parts, each containing three one-metre sections of corrugated wave-guide and a feed-back system. The radio-frequency power is derived from one magnetron, and is split to supply the same amount of power to each part. The design of the machine is very similar to that of the linear accelerator at Harwell, the details of which were described by Bareford and Kelliher¹, with the exception that the feed-back bridge in the rectangular wave-guide is of the 'rat-race' type instead of the circular 'magic tee', and that in the second part the corrugated wave-guide was modified to have a ratio of a/λ (a , radius of the iris in the guide; λ , wavelength) of 0.150, instead of 0.168 as in the first part. As a result of this modification, both the final energy and the efficiency of the machine were significantly increased.

In order to check the performance of the accelerator, measurements have been made of the energy of the electrons in the emerging beam, using a magnetic deflexion method, and of the mean power in the beam, using a water calorimeter. The graphs of Fig. 1 show the variation of the electron energy and of the pulse current with the gun filament current, which is a measure of beam loading. The pulse current was calculated from the mean current, assuming that the duration of each pulse was 1.3 μ sec. It is seen that a usable current is obtained even at an energy greater than 16 MeV. The optimum output is obtained at an energy of about 14 MeV., when the pulse current is 50 milliamperes. With an input pulse power from the magnetron of 1.8 megawatts, this corresponds to a pulse efficiency of about 40 per cent; the mean efficiency (ratio of mean beam-power to mean radio-frequency power) is about 25 per cent.

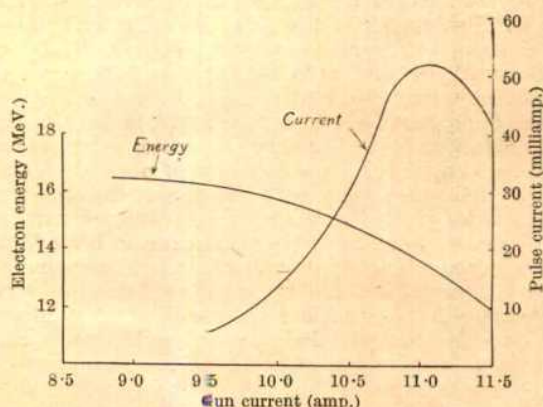


Fig. 1. Electron energy and pulse current as a function of beam loading (from measurements made at the Mullard Research Laboratories)

For therapy purposes the linear accelerator has been provided with an X-ray head (Fig. 2), in which the electron beam coming out from the wave-guide can be bent through 90° by means of an electro-magnet. In addition, the whole head can be rotated in a plane normal to the axis of the accelerator through an arc of 140°, so that the beam can emerge in any direction from 20° on one side of the downward vertical to 20° above the horizontal. For experimental purposes the electron beam can also be made to emerge in the straight-through direction; Fig. 3 shows a photograph of the electron beam emerging into the air through a beryllium-copper window.

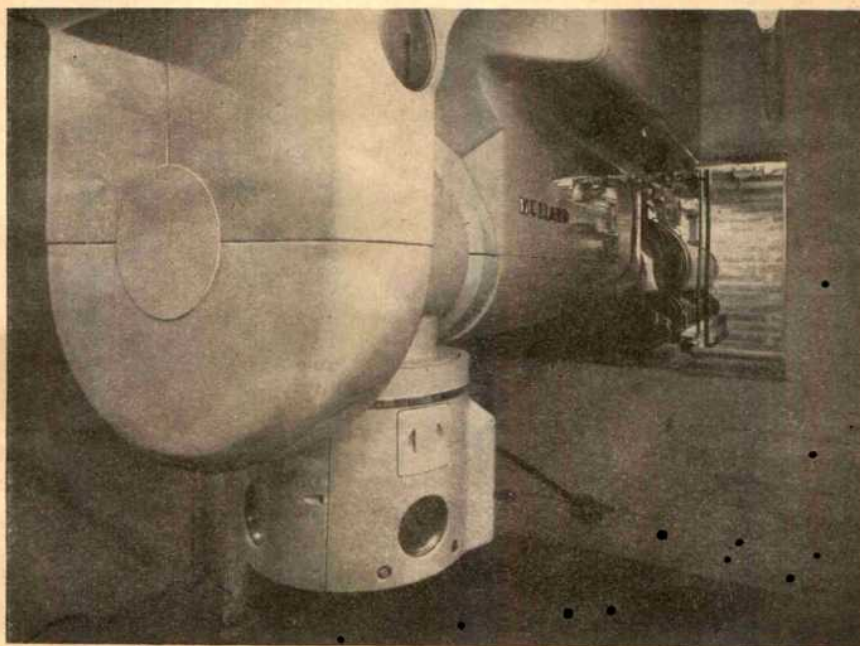


Fig. 2. X-ray head

In order to be able to select the different types of radiations which can be produced, the X-ray head contains a target holder which can be located in any one of three positions. In the first, there is no target and the electrons emerge directly into the air. In the second, they are made to strike a platinum target, resulting in the production of an X-ray beam. In the third, they strike a uranium cylinder, and the X-rays produced give rise to the emission of fast neutrons. The X-ray head contains several ionization chambers, to monitor the dose and dose-rate, and to centre the beam automatically, as well as the usual filters and diaphragms to flatten and define the X-ray beam. The aperture of the beam is rectangular and can be varied, by means of motor-driven lead diaphragms, so that at a distance of one metre the irradiated area can be varied from 0 to 20 cm. in one direction and from 3 to 28 cm. in the other direction.

The output of X-rays was measured in the straight-through direction using a tungsten target. Fig. 4 shows the X-ray output as a function of electron energy at a pulse repetition frequency of 500 per second. It is seen that at 14 MeV. the output is 3,300 r. per minute at 1 metre, decreasing to 1,100 r. per minute at an energy of 16 MeV. After passing through the filters and diaphragms the X-ray output will probably be reduced by a factor of about 3, but even then it will still be considerably greater than that available from any other radio-therapy set.

The very high output of radiations from the accelerator means that for many experiments the time of exposure would be very short; in fact, too short to be controlled by mechanical devices. For this reason, a new method for terminating exposures has been devised, namely, by means of a predetermined number of pulses. A special electronic device using dekatron tubes was designed and built which enables one to give an exposure consisting of any preset number of pulses, from 1 to 10,000. For many radiobiological experiments, single pulse exposures will be sufficient and a separate facility for this is provided. It is also possible to vary the pulse repetition frequency from 10 to 500 per second.

In order to avoid possible variations of intensity in the individual pulses, which may occur when the radio-frequency is switched on, the accelerator was modified to include deflecting coils near the gun end. When a current is flowing through the coils, the electron beam is deflected and prevented from passing along the accelerator until stable conditions have

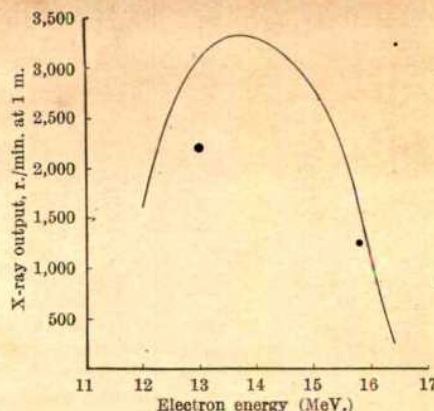


Fig. 4. X-ray output, at 500 pulses per second, as a function of electron energy

been attained. The effectiveness of the deflecting system was checked by measuring the X-ray output when the gun and radio-frequency were on at full power and the beam deflected, and comparing it with the output given by the undeflected beam. The ratio was found to be 1 in 30,000; it may be possible to reduce this ratio still further.

In the research programme, experiments have already begun on a number of problems. In the X-ray work, depth-dose determinations are being made as well as other measurements necessary before treatment can begin. In addition, experiments are being carried out to determine absolutely the energy deposited by the X-rays in tissue, using a calorimetric method. The properties of the electron beam are being investigated with the view of using it for electron therapy. Electrons of an energy of 15 MeV. have a range of 3 in. in tissue, and there are definite advantages in using such electrons chiefly due to their finite range. Similar studies are being made with the neutrons, in order to explore the possibilities of neutron therapy. The nuclear physics experiments are mainly concerned with photo- and electron-disintegrations; the emission of photo-neutrons and photo-protons, and the production of radioactive isotopes, are being studied using several techniques.

The main feature, however, of the linear accelerator which makes it particularly suitable for radiobiological research is its capability of delivering momentary doses of radiation at an exceedingly high rate. When tuned to optimum output, each pulse contains about 4×10^{11} electrons. Since the whole of the emerging beam is contained in a circle of 1 cm. diameter, this means that to a limited volume one pulse of electrons can deliver a dose of more than 15,000 r. This feature opens up the possibility of studying effects caused by radiation within a very short time interval after it has been delivered, since even one pulse of radiation is sufficient to produce an observable effect. Apart from the study of the kinetics of various radiation reactions, the effects resulting from the application of very high dose-rates lend themselves to investigation, for with a pulse duration of 1.3 μ sec. the dose-rate in the pulse can reach a value of 7×10^{11} r. per minute. Even when using multiple pulse exposures, the average dose-rate can be as high as 5×10^6 r. per minute.

Among the experiments to be carried out in radiobiological research is an attempt to measure the life-time of free radicals formed in irradiated liquids.

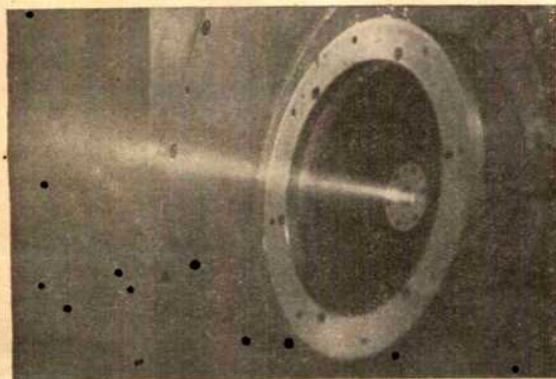


Fig. 3. Beam of electrons emerging from the X-ray head

by means of their absorption spectra. For this purpose, pulsed light sources have been developed which give intense flashes of light of about 1 μ sec. duration. These flashes will be synchronized with the pulse of radiation so as to obtain a series of absorption spectra at various intervals after the irradiation. In order to analyse the spectra, a high-speed rotating mirror with frictionless bearing has been built. In another series of experiments the effects of radiations on tissue enzymes are being studied, and experiments are in preparation for the investigation of the relationship between dose-rate and biological effects on the living cell by the use of the tissue-culture technique.

*Bareford, C. F., and Kellher, M. G., *Philips Tech. Rev.*, 15, 1 (1953).

RELAXATION AND FLOW IN GLASSES

THE British Society of Rheology held a symposium at Queen Mary College (University of London) on January 28 on the subject of "Relaxation and Flow in Glasses". The theme was introduced by Prof. G. O. Jones (Queen Mary College), who gave an account of the nature and physical properties of 'glass'—using the term in its broadest connotation to cover such substances as glycerol, glucose, water, ordinary inorganic glasses and silica, having widely differing chemical behaviour. In this sense the term has essentially a thermodynamic significance, and it is constructive to approach the study of glasses from this point of view.

In the thermodynamic hierarchy, glass is a doubly unstable liquid, the progress of which towards stability is inhibited because of its high viscosity. It is, first, unstable relative to any ordered crystalline state and will, under certain conditions, crystallize or 'devitrify'. However, in normal use, this does not occur. Of greater physical significance in the study of glass is its instability relative to the state of internal equilibrium which corresponds to ordinary supercooling of a liquid. The temperature at which the viscosity is 10^{18} poise (the 'transformation temperature', T_g) marks a rough boundary above which a glass-forming system is merely a supercooled liquid and below which it is a glass. At any temperature below T_g , the glass takes a finite time to reach the state of internal equilibrium corresponding to the particular temperature. The progressive approach to this state—often described as 'stabilization'—is normally shown macroscopically as a contraction. The significance of the figure 10^{18} is only that for most substances it corresponds to a Maxwell relaxation time of the order of the duration of ordinary experimental observations. As the temperature is lowered below T_g , the microscopic adjustments necessary for the attainment of the configuration appropriate to the actual temperature take longer and longer times. This has great practical significance in the manufacture of optical glass.

The rheological properties of a glass are of special interest since they can be assumed to imitate—but in slow motion—those of ordinary liquids. The reactions to an applied shear stress consist of a reversible elastic contribution—partly instantaneous and partly delayed or 'relaxing'—and an irreversible portion which is Newtonian viscous flow. Under a uniform compressive stress, there is, of course, no viscous flow, but again the two reversible reactions

appear. The almost exact formal correspondence between the delayed reaction in this case and the process of stabilization is of special interest.

By varying the temperature, the relative importance of the separate reactions to applied stress may be varied, and they can be studied individually by simple methods. At temperatures well above T_g , only the viscous flow is normally of importance. Near T_g the three types of reaction are of about equal magnitude in the time-scale of ordinary observations, and this gives rise to the possibility of observing frozen-in stresses between adjacent layers when glass in which a temperature gradient exists is cooled through the neighbourhood of T_g . The removal of these stresses (often known as 'strain') is the main function of 'annealing' processes in commercial glassware.

At sufficiently low temperatures the instantaneous elastic strain preponderates over the other reactions to applied stress, and glass (though still thermodynamically an unstable liquid) becomes in its mechanical properties the model of a brittle solid.

Mr. R. W. Douglas (Research Laboratories, General Electric Co., Ltd., and professor-designate of glass technology in the University of Sheffield) spoke of his work in collaboration with Mr. J. O. Isard on the density of fused silica near T_g , where, of course, physical properties may be functions of time as well as of other parameters. Because of its high transformation temperature (about 1,200° C.), silica has previously been somewhat inaccessible to such studies, and special methods have to be used. The typical experiment here consisted of heating the specimen of silica for a given interval at constant temperature, cooling quickly by withdrawing it from the furnace, and then measuring its density at room temperature. The specimen was again placed in the furnace and the whole process repeated until the measured density showed a constant value. A density thus measured contains, of course, a contribution from the thermal contraction during cooling to room temperature, and the coefficient of expansion governing this would be expected to change with time. In order to be able to make use of these measurements at room temperature to estimate the density at the original heating temperature, it was necessary to determine separately the effect of the heat treatment on the coefficient of expansion. The results show that this contribution accounts for about half the observed change in density.

The corrected equilibrium densities were found to increase as the temperature was increased in the range 1,050°–1,300° C., indicating that here fused silica has a negative coefficient of expansion if sufficient time is allowed for the atomic configuration to reach equilibrium. This behaviour appears to be analogous to that shown by water between 0° and 4° C., where the increase in density with rising temperature is attributed to the collapsing of the directed bonds. The well-known fact that the equilibrium configuration in glasses can be approached from both sides was demonstrated in these experiments for the case of silica.

Mr. Douglas went on to describe experiments on the release of mechanical stress in silica. It has long been known that the release of stress in glasses—for example, in annealing processes—does not follow the behaviour of the simple Maxwell body. Deviations from this behaviour must be partly due to the variation of viscosity with time and partly to the influence of delayed elastic (or visco-elastic) con-

tributions. Since the rates of approach to equilibrium in silica near T_g have been established from the experiments on density changes, an attempt was made to estimate how far the deviations from Maxwellian behaviour are due to varying viscosity by making measurements of the release of stress from time to time during the slow approach of a specimen of silica towards its equilibrium configuration. The specimen consisted of a thick-walled cylinder in which a slot had been cut. The stress could be introduced by inserting a wedge of fused silica into this slot, and the magnitude of the stress determined by observing the birefringence. The rate of release of stress (at constant strain) was found to decrease when the specimen was heated. Eventually it reached a constant value after a time about equal to that which had been found necessary for the attainment of the equilibrium density at the same temperature. However, even at equilibrium, the release of stress did not follow the pattern expected from a Maxwell body, and an important contribution from viscoelasticity appeared to be present. The experiments were not regarded as decisive because it was found that as the material approached equilibrium it appeared to become more and more inhomogeneous. This behaviour was attributed to the fact that the viscosity after first cooling from a high temperature would have nearly the same value throughout the specimen, but as the configuration reached equilibrium, differences in viscosity due to physical inhomogeneities might become more marked.

Dr. R. O. Davies (Queen Mary College) spoke of the possibility of giving a thermodynamic treatment of the process of attaining configurational equilibrium (or stabilization).

In order to do this, one must assume that the instantaneous state is fixed not merely by the pressure and temperature (say) but by one or more internal ordering parameters as well. The principle involved is not new, but has been used in chemical thermodynamics since the time of Gibbs. (In chemistry the internal parameters are 'degrees of reaction', describing the progress of chemical changes which can take place in the system.) With glasses the simplest procedure is that due to Tool, who introduced and used a 'fictive temperature' ($\bar{T}$), giving a measure of the internal state of the glass. When $\bar{T}$ is equal to the real temperature (T), the glass is in thermodynamic equilibrium and has its equilibrium structure; when it is not, the structure is that of a glass which would be in equilibrium at a temperature higher or lower than T (according as $\bar{T}$ is greater or less than T).

Alternatively, a 'fictive pressure' might be introduced. This is especially convenient in the discussion of experiments in which the pressure on the glass is varied, and can be used to give a qualitative explanation of some aspects of the recent experimental observations of P. W. Bridgman and I. Simon on volume changes in glass at very high pressure.

Tool's idea can be fitted into a rigorous thermodynamic formalism which—with appropriate extensions—should be applicable to any isotropic process in glasses. The main results for a single ordering parameter are: (a) a set of thermodynamic relations connecting the properties of a glass with those of the corresponding equilibrium liquid, (b) a means of predicting the kinetic behaviour under various experimental conditions (for example, isothermal-isobaric, adiabatic-isobaric, etc.) in terms of that observed under any one set of conditions.

Experimentally it is found that in no case which can be checked are the predictions under (a) exactly fulfilled. Those of (b) have never been tested. The reason for the failure of (a) is that one ordering parameter is not enough. This is especially conspicuous in the special case of borosilicate glass. To remedy this, more parameters must be introduced, and the limiting case is that of an infinity of parameters and a continuous distribution of relaxation times. Thus the thermodynamic theory becomes similar to the treatment of the general isotropic response of a linear body—a problem familiar to rheologists. The thermodynamic approach is, however, more flexible and attractive than the purely mechanical treatment.

It is clearly desirable to extend the thermodynamic treatment so as to deal with shearing motion as well. Here a curious situation appears. We should like to be able to exhibit delayed elasticity and flow as a special case of stabilization. It is possible to deal with delayed elasticity provided we exclude permanent deformation and admit a tensorial degree of order instead of a scalar quantity. Alternatively, it is possible to derive the Stokes-Navier equations for the case where there is no delayed elasticity but only permanent deformation. But the central problem of combining both reversible and irreversible fluidity within a single thermodynamic framework seems to be more difficult.

PROJECT 'SHOWER': AN INVESTIGATION ON WARM RAIN IN THE HAWAIIAN ISLANDS

By P. SQUIRES

Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, Sydney

ONE of the most interesting problems in the subject of the physics of rain is posed by rain which falls from clouds wholly warmer than freezing, often called simply 'warm rain'. The classical theory of the formation of raindrops expounded in 1933 by Bergeron envisaged a cloud of supercooled water droplets in which, as cooling proceeded, ice crystals began to form, usually at temperatures around -10° to -15° C. However, over the past ten years or so, many cases of 'warm rain' have been reported, and, after some hesitation, its existence is now universally accepted.

The basic problem in the formation of this sort of rain is to explain how a single cloud process can sometimes give rise to two families of drops: on one hand, cloud drops, and on the other, raindrops which are of the order of 10^5 times greater in mass. Some quite drastic form of selection in favour of a few of the droplets seems to be indicated. In the Bergeron process the singular character of the ice crystal in a cloud of supercooled water provides a key which seems adequate. In warm clouds it is not obvious what determines the selective growth of a small number of drops.

Condensation nuclei vary widely in size and effectiveness. This no doubt causes some cloud droplets, formed on the larger or more effective nuclei, to outgrow others. Nevertheless, it is generally agreed that this effect is quite inadequate to explain

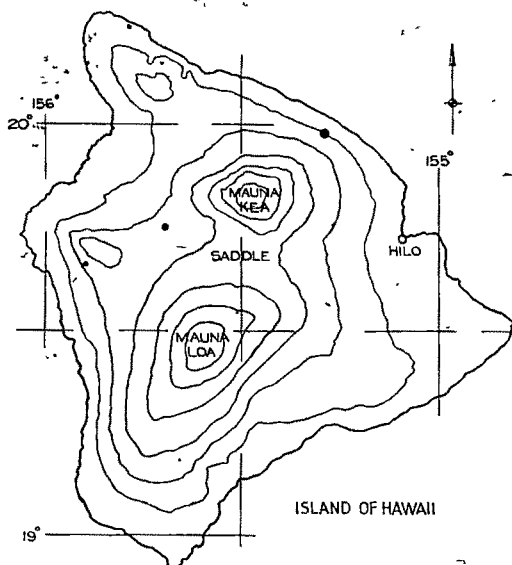


Fig. 1

the growth of raindrops in a cloud. If this is so, the raindrops must gain most of their water by colliding and coalescing with cloud drops. Computations have been made, by several authors, of the growth of a raindrop by this process, starting off from a somewhat bigger-than-average cloud droplet which as it fell through the cloud collected some of the droplets in its path. The view has been advanced that some of the giant sea-salt nuclei observed by Woodcock could outgrow the vast majority of the smaller nuclei and so provide the 'singular' particles which grow eventually to raindrops.

It is now well known that warm rain is very common in tropical maritime climates. A. H. Woodcock, of the Woods Hole Oceanographic Institute, has spent two periods of several months in the Hawaiian Islands during the past two years, studying the relation between sea-salt nuclei and warm rain. The advantages of these Islands for such studies are indeed striking. Lying in lat. 19°–22° N., they are subject most of the time to the Trade wind. For 2,000 miles around, there is no land except other small oceanic islands. The islands of Oahu and Hawaii have a simple topography: Oahu consists primarily of a 3,000-ft. ridge lying almost across the stream of the Trade wind, and Hawaii of two cone-shaped mountains, Mauna Kea and Mauna Loa, as shown in the map (Fig. 1); each of these reaches very nearly to 14,000 ft. Their slopes are gradual and extraordinarily regular. Between them is a 6,500-ft. saddle, thirty miles wide. The line of the peaks is very nearly north-south. The easterly stream of the Trade wind is broken here into three branches, one passing north of the Island, one south, and one through the saddle. A good road runs west from the city of Hilo on the east coast up through the saddle (about thirty miles away), so that measurements can be taken on the orographic rain which falls on this slope of the Island when the Trade wind is fairly strong. Finally, the airport at Hilo has full facilities, and the density of air traffic is not such as to cause inconvenience to experimental aircraft operating in the area.

The idea of a joint international project in Hawaii was sponsored by A. H. Woodcock, of Woods Hole,

and by W. A. Mordy, of the Meteorological Department of the Pineapple Research Institute of Hawaii and the Hawaiian Sugar Planters Association in Honolulu. The Office of Naval Research of the U.S. Navy provided funds to the Woods Hole Oceanographic Institute for the purpose, and the Radiophysics Division of the Commonwealth Scientific and Industrial Research Organization was invited to participate. Several other organizations were represented as well. The research workers who eventually assembled at Hilo early in October 1954 were: A. H. Woodcock, D. C. Blanchard and A. T. Spencer, from the Woods Hole Oceanographic Institute; W. A. Mordy, L. Eber and D. S. Johnson, from Mordy's Honolulu group; E. Eriksson, of the Institute of Meteorology, University of Stockholm; V. J. Schaefer, of the Muntalp Foundation; E. J. Workman and B. K. Seely, of the New Mexico Institute of Mining and Technology; C. E. Junge, of the U.S. Cambridge Air Force Research Center; E. A. Amman, of the U.S. Weather Bureau; J. Warner, P. Squires and S. Twomey, of the Division of Radiophysics, Sydney, of the Commonwealth Scientific and Industrial Research Organization. The U.S. Weather Bureau gave full co-operation, arranging for six-hourly radiosonde and rawind observations at Hilo, besides attaching a full-time meteorologist (E. A. Amman) to the project. The whole group was very conveniently housed in the National Guard Officers' Club alongside Hilo airport. Three aircraft were used: two light aircraft provided and flown by the agricultural aviation firm of Murrayair, and a Royal Australian Air Force Dakota flown from Australia and operated in Hawaii by an R.A.A.F. crew of six.

The Woods Hole group was equipped to measure sea-salt nuclei from aircraft and raindrop spectra on the ground. Mordy's Honolulu group undertook most of the ground observations, such as rainfall and pilot balloon observations. Schaefer and Workman were concerned with atmospheric electricity, Seely with measurements on sea salt using the sensitized gelatine strip method. Junge made measurements of the trace constituents of the atmosphere, and Eriksson of the salt and nitrogen content of rain samples collected by the Woods Hole and Honolulu groups. Warner and Squires were equipped to measure the liquid water content and temperature of clouds, and the spectra of droplets in them. Their Dakota aircraft was also equipped with 10-cm. radar for observing the distribution of rain in clouds. Twomey was concerned with measuring (on the mountain-side) the spectrum of raindrops and the charges on cloud drops.

Two themes were adopted as a basis for the measurements. Woodcock had earlier found evidence of a remarkable relationship between the salt content of the clear air over the sea, and that of the rain which fell on the windward slope of the Island. Accordingly, with Blanchard and Eriksson, he took samples of airborne sea salt over the sea on each day when the Trade Winds blew, and made measurements on the spectrum of the raindrops falling on the mountain-side and on the bulk salinity of rain samples taken over short periods by means of a large (1 m.²) funnel. Eriksson also analysed these samples for nitrogen, and the comparison of his results with Junge's promised to be fruitful.

The remaining resources of the project were not directed to any particular aspect of the problem of warm rain. On the contrary, the aim was to get as

complete a picture of the whole process as possible. The objective chosen to give coherence to the observations was the simplest one that came to mind: to concentrate all the observations on the central stream of the Trade Wind which climbs up the mountain-side and passes through the saddle; to measure the properties of the air as it crosses the coast and again as it debouches through the saddle, and to see whether the depletion of its water vapour and sea-salt content could be related to the amount of rain which fell on the slopes, and to the salinity of the rain. The Trade Wind inversion provided a convenient and easily recognized upper boundary to the mass of air involved in the experiment.

This 'budget' operation, as it was called, required the co-operation of many people. On one day, the mass of air chosen for investigation was that which crossed the coast between 1 p.m. and 3 p.m. It was estimated that it would take two hours to reach the saddle, so that it would be passing out of the experimental area between 3 p.m. and 5 p.m. Between 1 and 3 p.m., two light aircraft patrolled offshore, and observations were taken of the sea-salt spectrum, the temperature and humidity of the air, and the water content of clouds, up to the base of the inversion. During the same period, pilot balloons were run at stations along the coast in order to determine the boundaries of the stream which converged into the saddle. At 1 p.m. observers set off on two parallel roads towards the saddle, emptying and rinsing out the hundred rain gauges which had been set out at intervals of a mile apart. They aimed at reaching the saddle at 3 p.m.; at that time other observers followed up along the same roads, measuring the rain which had fallen in the two-hour period and taking samples for salinity determinations; they aimed at arriving at the saddle area at about 5 p.m. At 2.30 p.m. the Dakota aircraft took off, climbed over the sea, taking soundings of temperature and humidity, and then went inland above the orographic cloud to the saddle. Here there was usually a clear space, and a sounding was made as low down as possible, usually to within 500 ft. of the ground, measuring temperature, humidity and sea-salt content. The Dakota continued observations until 5 p.m., alternately sounding in the saddle area and making runs down the mountain-side to Hilo in the orographic cloud, at fixed ground clearances, usually 1,000 and 2,000 ft. On these runs the liquid water content and droplet spectra of the orographic cloud were observed. During the period 1 p.m.-5 p.m., the spectrum of the raindrops was observed at two levels on the slope, and electric charges on cloud droplets at one level. A 10-cm. and a 3-cm. radar observed the motion of showers; cameras on the upper slope of Mauna Loa recorded the motion of the cloud tops, and anemometers at the coast, on the slope, and in the saddle measured the run of the wind.

Despite an unusually fine stretch of weather during November, a great deal of information was gathered. Several months will be needed to reduce all these observations to tabular form for publication later this year.

The burden of the many detailed arrangements for so large a group of people inevitably fell on the Honolulu group who acted as hosts; without their efficient organization of accommodation, transport and the like, much less would have been achieved. Excellent co-operation was given, too, by the aeronautical and defence authorities at Hilo Airport, and by the people of Hilo.

OBITUARIES

Mr. J. F. Didusch

JAMES FRANCIS DIDUSCH, internationally known as a medical and embryological illustrator, died on March 16 in Baltimore, where he was born on June 17, 1890. His grandfather was an artist-lithographer in Munich, Germany, and his father a sculptor and wood-carver in Baltimore. James Didusch studied both mechanical drawing and the fine arts at the Maryland Institute of Art and Design, and medical illustration with the late Max Broedel at the Johns Hopkins Medical School. In 1913 he joined the newly formed Department of Embryology of the Carnegie Institution of Washington, and worked in its Baltimore laboratory during his entire professional career with only one brief interruption.

Didusch illustrated the researches of the distinguished embryologists, F. P. Mall and George L. Streeter, and their colleagues with a remarkable combination of accuracy and beauty. He would never draw anything which he could not see clearly and comprehend. Thus he acquired a sound knowledge of human development, and himself became a contributor to the precision and clarity of work published from the Department and sometimes an anonymous colleague in the research. Although from time to time he also illustrated clinical books and articles, his real life-work is in the successive volumes of the Carnegie Contributions to Embryology. Among hundreds of drawings, it is difficult to choose those which best illustrate his beautiful style. Notable among his early work are the plates for L. H. Weed's monograph on the cerebro-spinal spaces (Vol. 5) and for Florence Sabin's article on the primitive blood vessels (Vol. 6). Later on he drew a series of pictures of important human embryos which have become classics of embryological art and are widely copied in the text-books, the finest of all perhaps being the lateral view of a 10-somite embryo, Carnegie 5078, in Volume 20 of the Contributions. A special talent for clear and simple diagrammatic representation without losing the similitude of animal tissues is shown by a page of diagrams illustrating the placentation of the rhesus monkey, Vol. 27, p. 9. Even in the last volume published in his lifetime (Vol. 35) the drawings for L. J. Wells's monograph on the diaphragm, made when his health was already failing, show his characteristically firm touch in line drawing and his refined half-tone style. Didusch carried his zeal for perfection all the way to the press-room, where he often supervised the inking of the rollers or helped mix the colours so that the drawings would be properly printed.

Mr. Didusch was a man of very sociable disposition. Loving good music, good food and a good story, he endeared himself to all his fellow workers, who will remember him as a generous friend as well as a stimulating collaborator and one of the greatest scientific illustrators of his time.

GEORGE W. CORNER

Mr. W. R. Sherrin

WILLIAM ROBERT SHERRIN was born at Twickenham on May 20, 1871, and died at South Norwood, London, on March 22 after a long failing in health. He was a son of John Sherrin, R.I., from whom he inherited a skill of hand, brush and pencil. As a boy he was sickly, and an outdoor life was prescribed:

partly for this reason his education was neglected, though, for a time, he attended Taplow Grammar School. When he was eight years old his family moved to Ramsgate, and he soon began to wander about the Isle of Thanet and became an avid collector of natural history specimens. Later, he opened a taxidermist's shop at Ramsgate. His ability at mounting and at dissection led to his appointment in 1895 as an articulator in the Zoological Department of the British Museum (Natural History). His health by then had so improved that for many years he cycled to and from Southend-on-Sea, where he had gone to live; until recently he rose at 4 or 5 a.m. and worked at whatever extra task he had on hand. He was employed in the Zoological Department of the Museum until 1928, his manipulative excellence being signalized by the naming after him of a rat from Sind and a bat from New Guinea.

In 1919 Sherrin was appointed curator and secretary of the South London Botanical Institute. This Institute at South Norwood, with a large and valuable herbarium and library, was founded by A. O. Hume in 1911, "to promote, encourage, and facilitate amongst the residents of South London, the study of the science of Botany". To some this appointment was surprising; but Sherrin was a well-known amateur botanist with a special interest in grasses, sedges and, more particularly, mosses. He

was attracted to mosses because they were so often used as packing for zoological specimens: the frequency of *Sphagnum* may have led to his study of this difficult genus, on which he published "An Illustrated Handbook of the British Sphagna" in 1927.

No longer able to put in full time at the British Museum, he worked from 8 a.m. to 12 noon. In 1928, at his request, he was transferred to the Department of Botany to take charge of the moss collection after A. Gepp's retirement. He continued there until 1947, and on leaving the Museum was awarded a Civil List pension.

Sherrin was highly successful at South London, applying himself with energy and devotion to running the Institute. He was a born teacher—though not a good lecturer—and had an inspiring and helpful influence on young and old seeking a knowledge of plants, as several who became eminent botanists have testified. The field excursions which he regularly conducted were of great value not only to adult members of the Institute but also to university students and others who found stimulus and satisfaction in his knowledgeable enthusiasm.

He was elected an associate of the Linnean Society of London in 1919, and recently a life-member of the Zoological Society. He served as president of the British Bryological Society during 1947–48.

J. RAMSBOTTOM

NEWS and VIEWS

Sir German Sims Woodhead, K.B.E. (1855–1921)

GERMAN SIMS WOODHEAD, who was born one hundred years ago on April 29, 1855, came of old Yorkshire Quaker stock, and was educated at Huddersfield College and then at the University of Edinburgh, where he graduated in medicine in 1878, taking his M.D. three years later. After postgraduate studies in London, Berlin and Vienna he became demonstrator of pathology at Edinburgh under W. S. Greenfield and superintendent of the research laboratories of the Royal College of Physicians of Edinburgh. In 1890 he was appointed director of the Conjoint Board's laboratories in London. In the *Lancet* laboratory Sims Woodhead investigated incandescent gas lighting, the flashpoint of lamp oils, and the standardization of disinfectants. In the early days of diphtheria antitoxin he placed its manufacture in Great Britain on a sound basis. As assistant commissioner of the Royal Commission on Tuberculosis, he became a recognized authority on that disease, and with P. C. Varrier-Jones he founded the Papworth Colony near Cambridge in 1918. In 1899 he succeeded A. A. Kanthack as professor of pathology in the University of Cambridge, where he played a leading part in the planning of new laboratories. His best-known books are "Practical Pathology" (1883), for many years the standard text-book for students, and "Pathological Mycology" (1885) with A. W. Hare. Sims Woodhead founded the *Journal of Pathology and Bacteriology*, of which he was the sole editor until 1906, when he continued as editor-in-chief until 1920. For his work on chlorination of water for the supply of troops and for other war services he was created K.B.E. in 1919. He was president of the Royal Microscopical Society and of the Pathological and Bacteriological Laboratory Assistants' Association, which he was instrumental in organizing. A militant teetotaler, a genial companion and a delight-

ful host, Sims Woodhead died on December 29, 1921, after a long period of failing health.

Honorary Fellowships of the Imperial College of Science and Technology, London

THE following have been elected to honorary fellowships of the Imperial College of Science and Technology, London: Dr. Eric Ashby, president and vice-chancellor of The Queen's University, Belfast; Mr. L. C. Hill, technical adviser to the board of the Rio Tinto Company; Sir George Nelson, chairman and managing director of the English Electric Co., Ltd.; Prof. J. A. S. Ritson, emeritus professor of mining in the Imperial College; Sir George Thomson, master of Corpus Christi College, Cambridge, and emeritus professor of physics in the Imperial College.

Pastoral Research at Armidale, New South Wales

A SMALL research committee is being established by the Commonwealth Scientific and Industrial Research Organization, Australia, and by the University of New England, so that pastoral research by the staff at the Armidale Regional Pastoral Laboratory of the C.S.I.R.O. and by the University's newly established Faculty of Rural Science will be closely linked and that the resources of both can be related and used to best advantage. For the time being, the committee will comprise the following: Prof. G. L. McClymont, recently appointed to the chair of rural science at the University of New England, who will act as chairman and University representative; Mr. R. Roe, the senior officer at Armidale of the Division of Plant Industry, C.S.I.R.O., who will be deputy chairman and representative of the Division of Plant Industry; Dr. A. T. Dick, of the Division of Animal Health and Production, Parkville, who has been appointed because of his outstanding knowledge and experience

in the problems of animal and plant relationships; and Mr. J. F. Barrett, of the Armidale Laboratory, who will act as secretary and executive officer of the committee. The chiefs of Divisions of Plant Industry and Animal Health and Production of the C.S.I.R.O. will be *ex officio* members.

Recent Earthquakes

DURING February and March seven earthquakes occurred having logarithmic magnitude greater than 6. The greatest of these occurred on February 27 in the Kermadec Islands region, and had a magnitude of 8. The next greatest occurred on March 31 near the north-west coast of Mindanao in the Philippine Islands. In this latter shock most destruction appears to have happened in the Lake Lanao region, with Ilagan, Dansalan City and Ozamis City the most affected places. In Ozamis City the Catholic church and many port facilities collapsed, and water and electricity systems were seriously damaged. The property damage left some ten thousand people homeless, 425 persons being killed and two thousand injured. On February 18, fourteen persons were killed during an earthquake which caused moderate property damage at Quetta (see *Nature*, February 26, p. 370). A deep-focus earthquake, having a focal depth of 600 km., occurred on February 8 in southern Bolivia, and two on February 23 in the Fiji Islands region. European earthquakes occurred on February 9 at Foggia in southern Italy, on March 18 at Benevento in Italy, on February 17 near the north coast of Sicily and on February 21 near lat. 39° N., long. 23° E. This last caused damage and casualties at Volos in Greece. On March 28 a further earthquake occurred near the south coast of Greece causing damage at Pirgos. On April 11 a second shock occurred at Mindanao, causing further property damage, while on April 19 and 21 further shocks occurred near Volos in Thessaly. On April 19, after a minor tremor, the earthquake caused the collapse of three hundred houses and damage to four-fifths of the buildings in Volos. Only one person was killed and forty-two injured, but more than three thousand were rendered homeless. The second strong shock on April 21 caused the collapse, to the accompaniment of large clouds of dust, of many of the buildings weakened by the first shock, so that now, in a town of some fifty thousand inhabitants, only about a hundred houses remain standing. Government House is so damaged that it is uninhabitable. In this second earthquake near Volos within forty-eight hours, six or more persons were killed and more than sixty seriously injured.

Sandwich Training and Education

THE case for 'sandwich' courses consisting of full-time work in industry alternating with full-time study in senior educational institutions was discussed at a meeting arranged by the Southern Regional Council for Further Education at Southampton in October 1954. The chief advocates were Sir Arthur Smout and J. Wilson, principal of the Birmingham College of Technology. Sir Arthur argued that these courses are particularly valuable for young men who have just failed to comply with a certain standard imposed as a condition of matriculation—the 'near pass' man. Through sandwich systems of training, these men might well develop into promising technologists instead of becoming technicians. To make sandwich courses effective, he said, industrialists must get away from

the idea that all higher education must be of the university type, governed by university standards and inspired by university ideals.

In his address, Principal Wilson stated that sandwich training and education courses are mainly the concern of the technical colleges. Their objectives should be to achieve a technological standard not less than, and probably higher than, that connoted by the Higher National Certificate; to give a broad knowledge of the fundamental sciences on which a particular technology is based; to relate studies in which a student-apprentice is primarily engaged to those other branches of technology in order to avoid narrow specialization; to integrate theoretical studies with practical training, particularly during the last year of the course; to give some understanding of the historical and economic basis of society in relation to industry; and to develop powers of expression and social competence necessary for a person to play an effective part in an industrial organization.

Marshall Aid Commemoration Commission: Report for 1954

UNDER the Marshall Aid Commemoration Act, 1953, a Marshall Aid Commemoration Commission was appointed by the Secretary of State for Foreign Affairs, with Sir Oliver Franks as chairman, and the first annual report, covering the year ended September 30, 1954, has now been issued (Cmd. 940. London: H.M.S.O., 1955; 3d. net). The Commission, which includes among its members Lord Adrian and Lord Baillieu, with Sir Charles Morris and Sir Philip Morris *ex officio* as, respectively, chairman of the Committee of Vice-Chancellors and Principals and vice-chairman of the Association of Universities of the British Commonwealth, was in operation for only part of the year, and its two meetings were concerned largely with planning for the first group of twelve Marshall scholars to take up their studies in Britain in October 1954. Of these twelve, one is studying political science, another industrial relations and a third anthropology, at the London School of Economics and Political Science; a fourth is studying the physics of metals at the University of Bristol, and the remainder are reading history, law, classics, literature, economics or oriental studies. Some minor amendments have been made to the regulations for the next elections of Marshall scholars, providing a more precise definition of the age-limit for candidates, for payment of candidates' travelling expenses to interviews, for rejection of incomplete applications, the inclusion of employment as qualification for application in a particular region and for clarification of the position about holding another award. No accounts are presented, as the expenditure of £1,877 for the year ended March 31, 1954, was borne by the Foreign Office. Expenditure for 1954-55 is estimated at £9,312.

Chemical Branch of the London County Council

THE report for 1953 of the London County Council Medical Officer of Health and Principal School Medical Officer contained an account of the Chemical Branch, including a history of the Branch since its formation, prepared by Mr. C. J. Regan, who retired from the position of chemist-in-chief in March 1954; and this latter report has now been reprinted under the title "The Application of Chemistry and Allied Sciences to the Public Service". A consulting chemist was first appointed to the Metropolitan Board of

Works in 1869, and in 1878 this became a full-time appointment, when a Chemical and Gas Department was formed. In 1889, after the constitution of the London County Council, the Council took over the functions of the Board of Works, the duties of which were then largely concerned with sewage disposal and gas supplies. When treatment of sewage by chemicals was introduced, this became a joint service between the chief engineer and the chemist. Other chemical work carried out at the formation of the London County Council dealt with the examination of general stores such as soaps, oils, etc., and of foodstuffs for residential institutions, and statutory work on the testing of petroleum in relation to the issue of storage licences.

In 1912 the Chemical and Gas Department was abolished, and the bulk of its work was merged in the then rapidly developing Public Health Department, of which it became the Chemical Branch. Mr. Regan reviews the way in which the work of the Branch has grown in complexity with the advance of scientific knowledge and also emphasizes the economic value of its work, for example, in the preparation of approved lists of paints and checking the qualities of deliveries of paint, which have reduced to an exceedingly low level failures among paint, an item on which more than a million pounds a year is spent. More than twenty-five thousand samples were examined in 1953, the most numerous categories being samples of river water, sewage and effluent, primary and digested sludge, water from steam-raising plant, clay, sub-soils and borehole waters, and paints, varnishes and distempers. The staff of fifty-four includes twenty-seven professionally qualified chemists; the report abounds in examples of the way in which the work of the Branch safeguards public health and welfare.

Nutrition of the Rubber Tree

A RECENT issue of the scientific journal of the Rubber Research Institute of Malaya contains two contributions on the nutrition of the rubber tree. E. W. Bolle-Jones (*J. Rubb. Res. Inst. Malaya*, 14, 231; 1954), using seedlings of a particular clone of *Hevea brasiliensis* grown in pot sand culture, has investigated the inter-relationships of magnesium, potassium and phosphorus on growth. A close inter-relationship between the three nutrients, affecting the growth and composition of the plant, was demonstrated. It was found that the concentrations of rubber in the stems and petioles varied slightly with nutrient-levels, and that they were inversely related to the dry-weight values. The same author, with K. Ratnasingam (*ibid.*, 257), has also investigated inter-clonal and seasonal variations in the composition of leaves. By appropriate sampling and analysis of three clones, they have found that the petiolar rubber concentration and the laminar concentrations of chlorophyll, ash, nitrogen, phosphorus, magnesium, potassium, calcium and iron varied according to the clone. With increasing age of leaf there were increases in the petiolar concentration of rubber and the laminar concentrations of chlorophyll, ash, calcium, iron and manganese, but decreases in the laminar concentrations of nitrogen, phosphorus and potassium. The month of sampling had an important effect on the concentration of each variable examined. It also had a significant influence on the effect of whorl position (or age of leaf) on the concentrations of rubber, chlorophyll, phosphorus and calcium found. Different clones showed different effects in relation

to month of sampling. Seasonal variations in the rubber, nitrogen and iron concentrations could be attributed in part to rainfall distribution. It was also ascertained that the concentration of rubber in the petiole varied according to the nitrogen concentration in the blade, and that this in turn was influenced by the calcium concentration.

Status of Invertebrate Palaeontology: 1953 Toronto Conference

THE fourteen papers on "The Status of Invertebrate Paleontology" presented at a symposium in Toronto in 1953 have been published in the *Bulletin of the Museum of Comparative Zoology at Harvard College* (112, No. 3, 91; 1954. 2.50 dollars). The authors are American, British and German members of an international team working to produce a "Treatise of Invertebrate Paleontology" under the editorship of R. C. Moore, of Kansas. (Since the symposium was held, two parts of this "Treatise", obtainable from the Geological Society of America at 3 dollars each, have been published: Part D, Protista 3, Protozoa (chiefly Radiolaria and Tintinnina), by A. S. Campbell and R. C. Moore; and Part G, Bryozoa, by R. S. Bassler.) Following two short introductory articles are nine contributions, each intended for non-specialists, to assess the present state of knowledge concerning classification, patterns of evolution and geological history of a particular group.

Such authoritative accounts are welcome to biologists in both ancient and modern fields. The non-specialist level, inevitably, is placed differently from group to group, and sometimes a bibliography is offered and sometimes not. Familiar groupings now held to be of polyphyletic origin are discarded or their demise is threatened; healthy doubt and ignorance prevail concerning some phylogenies, and in one major group no classification is visualized at present above the superfamily category. The groups treated are: Protozoa by H. E. Thalmann; Coelenterata by J. W. Wells; Pelmatozoa by R. C. Moore; Eleutherozoa by J. W. Durham; Pelecypoda by N. D. Newell; Gastropoda by J. B. Knight, R. L. Batten and E. L. Yochelson; Cephalopoda by B. Kummel; Trilobita by H. B. Whittington; and Graptolithina by O. M. B. Bulman. A Petrunkevitch's essay entitled "Macroevolution and the Problem of Missing Links" offers an explanation why speciation alone fails to account for apparent evolutionary discontinuity. The remaining articles are concerned respectively with the ammonoid suture (O. H. Schindewolf), with the evolution of late Palaeozoic invertebrates in response to major oscillations of shallow seas (R. C. Moore) and with various aspects of skeletal materials (H. A. Lowenstam). This stimulating publication has been edited by B. Kummel, who was the chairman of the symposium.

Extraction of Small Fragile Ammonites

In the February issue of the *Museum Journal*, Mr. C. P. Watkins outlines an inexpensive method for hardening, extracting and developing the surface detail of small, thin, fragile ammonites which occur in the Lower Lias shales of Leicestershire. The top cover of matrix is removed and the specimen immersed in industrial alcohol for five minutes. The matrix is smeared with 'Vaseline', and a thin layer of shellac is painted over ammonite and 'Vaseline' and allowed to harden. When the film is removed, the ammonite

generally adheres to it. The under-surfaces of the ammonite and film are cleaned with benzolene and fragments of matrix removed. After drying, the specimen is placed film downwards on a glass sheet smeared with 'Vaseline'. A shellac film is painted on, and at the tacky stage a paper slip with registration number is affixed. When hard, the edges of the shellac are trimmed with a pair of scissors. Surface relief may be increased by treating the shellac surfaces with alcohol.

National Museum of Wales: Report for 1953-54

THE annual report for 1953-54, of the National Museum of Wales (pp. 63+4 plates; from the Museum, Cardiff; 1954) appears again in its new format and stresses the most urgent needs which were formulated by the Standing Commission in 1953. These include the erection of the western extension of the Museum and a museum block at the Welsh Folk Museum at St. Fagans. Although the first need remains in abeyance, a start has been made on the new Folk Museum at a cost of approximately £15,000. An "Exhibit of the Month" is now a regular feature. This is arranged in turn by the departments concerned. The Department of Archaeology reports a full programme of field-work. At Caerleon, Dr. V. E. Nash-Williams undertook the exploration of a five-acre site outside the Roman legionary fortress. A legionary civil settlement was proved, and datable material suggests that the buildings were in occupation from A.D. 100 to 300 or later. The site was also exceptionally rich in small finds. In addition to carrying out much extra-mural work of a character cognate to their normal museum tasks, the staff are responsible for an impressive list of publications.

Science and the Press

THE greater part of the March issue of the *Atomic Scientists Journal* is devoted to a symposium on science and the Press. The symposium included that part of Mr. L. J. F. Brimble's lecture to the Royal Society of Edinburgh in January 1954 which dealt with the interpretation of science; a contribution from Mr. L. Bertin, science correspondent of the *Daily Telegraph*, in which the position of the journalist is explained with clarity and understanding and the qualities demanded of a science writer are indicated; a discussion by Mr. Ritchie Calder of some causes of misunderstanding between scientific workers and journalists; and a summary by Dr. A. V. Cohen of the main points in a set of articles on the relations between scientific workers and the press contributed to the November 1953 issue of the *Bulletin of the Atomic Scientists* (U.S.A.). Mr. Calder's constructive article includes the statement that, in his opinion, a science editor should leave out, as scientifically dubious, scientific news which, for reasons of space, cannot be expounded or qualified, even though it may be *prima facie* of journalistic interest. He also stressed the difference between the presentation of scientific facts and helping people to understand the effects of scientific development. For satisfactory relations between scientific workers and the Press one condition is fundamental: the facts are inalienably the concern of the man of science, but their treatment is the function of the scientific journalist, for which he is trained.

Man's Role in Changing the Face of the Earth

THE Wenner-Gren Foundation for Anthropological Research, New York City, with the aid of the

National Science Foundation, Washington, D.C., is organizing an international symposium on "Man's Role in Changing the Face of the Earth", to be held during June 16-22 at the Princeton Inn, Princeton, N.J. Participation is limited to eighty invited experts, of whom seventeen are from outside the United States, representing India, Egypt, Israel, France, Belgium, Germany, Great Britain and Canada. The symposium will explore the question: What has been, and is, happening to the earth's surface as a result of man having been on it for a long time, increasing in numbers and skills in an uneven manner, with respect to place and time? The three main factors involved are: the earth's resources; the numerical pressure of population upon, and sustained by, the resources; and man's differing cultures, or ways of life. Fifty-two background papers, each reviewing some particular aspect and outlining the problems for future research, will be presented. Further information can be obtained from the organizer of the symposium, William L. Thomas, jun., Wenner-Gren Foundation, 14 East 71st Street, New York 21.

Cold Spring Harbor Symposium on Population Genetics

THE twentieth Cold Spring Harbor Symposium on Quantitative Biology will be held during June 6-13, the subject being "Population Genetics: the Nature and Causes of Genetic Variability in Populations". The object of the Symposium will be to bring leading workers together in an effort to establish an area of agreement on fundamental concepts common to both agricultural genetics and evolutionary genetics, and to this end the discussions will be focused on the following topics: general population genetics theory; theory of quantitative genetics; selection in plants; selection in animals; genetic variability and polymorphism; populations in time and space; and integration of genotypes. The Symposium is open to all who are interested. Further information can be obtained from the Biological Laboratory, Cold Spring Harbor, New York.

University of London

THE following appointments have been made in the Imperial College of Science and Technology: Dr. J. McG. Bruckshaw, reader in geophysics in the College, to the University chair of applied geophysics; Prof. D. G. Christopherson, professor of mechanical engineering in the University of Leeds, to the University chair of applied science with special reference to engineering; Dr. Arthur Porter, head of the Research Division of Ferranti Electric, Ltd., Toronto, to the University chair of light electrical engineering.

Other appointments include the following: Dr. William Holmes, assistant in animal husbandry at the Hannah Dairy Research Institute, to the University chair of agriculture tenable at Wye College; Dr. J. G. Powles, I.C.I. Fellow in the University of Durham, to the University readership in experimental physics tenable at Queen Mary College; Dr. G. B. West, lecturer in pharmacology in the University of St. Andrews, to the University readership in pharmacology tenable at the School of Pharmacy.

The Night Sky in May

FULL moon occurs on May 6d. 22h. 14m. U.T., and new moon on May 21d. 20h. 58m. The following

conjunctions with the moon take place: May 7d. 06h., Saturn 6° N.; May 20d. 02h., Venus 6° S.; May 23d. 10h., Mercury 2° N.; May 23d. 18h., Mars 1° N.; May 25d. 17h., Jupiter 3° N. In addition to these conjunctions with the moon, Jupiter is in conjunction with Pollux on May 6d. 18h., Jupiter 6.3° S. Mercury sets at 20h. 10m., 21h. 45m. and 21h. 30m. on May 1, 15 and 31, respectively, and owing to its increasing northern declination it is better placed for observation than it was in April; seen in the western sky, its stellar magnitude varies from -1.4 to 1.4 during the month, the visible portion of its illuminated disk decreasing from 0.928 to 0.178 and its distance from the earth decreasing from 117 to 62 million miles. Venus rises at 3h. 50m., 3h. 25m. and 3h. at the beginning, middle and end of the month, respectively, its stellar magnitude varying from -3.4 to -3.3 and the visible portion of its illuminated disk from 0.837 to 0.904; in spite of this increase in the visible portion of the illuminated disk, the stellar magnitude remains nearly the same because its distance from the earth increases from 125 to 140 million miles. Mars sets at 22h. 25m., 22h. 15m. and 22h. on May 1, 15 and 31, respectively; its easterly movement from Taurus into Gemini is easily seen, and towards the end of the month it is fairly close to the stars μ and η Geminorum. Jupiter is visible until late in the night, its times of setting being 1h. 05m., 0h. 20m. and 23h. 20m. at the beginning, middle and end of the month, respectively; its eastward movement from south of α Geminorum into the constellation Cancer is easily observed, but the small decrease in brightness, from magnitude -1.6 to -1.5 , owing to an increase of nearly 40 million miles in its distance from the earth, is not obvious to the naked eye. Saturn is in opposition on May 9 and sets in the early morning hours at 5h. 15m., 4h. 15m. and 3h. 10m. on May 1, 15 and 31, respectively. It has a slow movement towards Librae, its stellar magnitude varying between 0.3 and 0.4 owing to its distance from the earth increasing from 828 to 833 million miles. The star 55 Leo. is occulted on May 1d. 22h. 03.9m., the only occultation of stars brighter than magnitude 6 during the month. The Aquarid meteors are active during May 1-6, but moonlight may make their observation difficult during part of the time.

Announcements

THE Paris Academy of Sciences has elected Prof. Jean Timmermans, professor of physical chemistry in the University of Brussels, and Prof. Arne Tiselius, professor of chemistry in the University of Uppsala, to be *correspondants* for the Sections of Free Academicians and of the Application of Science to Industry in succession to the late Prof. E. Hubble, and Prof. M. Siegbahn, recently elected a foreign associate of the Academy.

WE regret to announce the following deaths:

Major F. B. Halford, C.B.E., chairman and technical director of the de Havilland Engine Co., Ltd., president during 1951-52 of the Royal Aeronautical Society, on April 16, aged sixty-one.

Dr. H. R. Raikes, principal and vice-chancellor of the University of the Witwatersrand until 1954, on April 13, aged sixty-three (see also *Nature*, 173, 17; 1954).

IN a Parliamentary written reply, it is announced that the following committee has been appointed to

review the organization of the Meteorological Office in relation to current and future requirements: Lord Brabazon of Tara (chairman), Sir Charles Darwin, Major R. H. Thornton, Sir Polliott Sandford and Mr. J. R. Simpson.

THE Road Research Laboratory of the Department of Scientific and Industrial Research is holding two open days during May 12-13 (10 a.m.-5 p.m.), when both the Materials and Construction Division at Harmondsworth and the Road Safety Division at Langley will be exhibiting their latest research work and giving practical demonstrations. Application to visit the Laboratory on either of these two days should be made to the Director of Road Research, Road Research Laboratory, Bath Road, Harmondsworth, Middlesex.

THE Society for Applied Bacteriology will hold its summer conference and annual meeting in Cambridge during July 4-6. The first two days will be devoted to a symposium on food microbiology and public health, at which sixteen papers will be read, six by workers from overseas countries. The subjects to be dealt with at the symposium will be synthetic cream, etc., fruits and vegetables, fish, fresh meat, processed meat, and bacteria causing food poisoning. Further information can be obtained from the honorary secretary, G. Sykes, Microbiology Division, Boots Pure Drug Co., Ltd., Nottingham.

THE tenth specialized course for physicists and electronic engineers on the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry and in work with radioisotopes will be held in the Isotope School, Atomic Energy Research Establishment, during May 23-26. Attendance at the course, which will be entirely non-secret, is limited to twelve. The fee is 12 guineas, and accommodation can be arranged locally at a charge of 4 guineas approximately. Application forms, to be returned by May 6, can be obtained from the D.A.O., Electronics Division, A.E.R.E., Harwell, Didcot, Berks.

A SUMMER school in theoretical chemistry for university and college teachers of chemistry and chemical research workers in industry will be held in the University of Oxford during September 10-24 under the direction of Prof. C. A. Coulson, with Prof. M. J. S. Dewar (London) and Prof. H. C. Longuet-Higgins (Cambridge) as lecturers. Three courses of lectures will be given on the general principles and theory of valence; the structure and properties of π -electron systems; and chemical reactivity. In addition, there will be a number of discussions and also opportunities to make calculations using desk calculating machines. The fee for the whole course, which is residential, is £32. Application must be made before June 15, application forms and further information being obtainable from the Secretary, Oxford University Legacy for Extra-Mural Studies, Rewley House, Wellington Square, Oxford.

THE Royal Society of Edinburgh is offering a David Anderson-Berry Silver-gilt Medal, together with about £100, for work on the therapeutical effect of X-rays on human diseases. Applications for the Prize should be accompanied by details of both published and unpublished work. Applications must be sent by March 31, 1956, to the General Secretary, Royal Society of Edinburgh, 22-24 George Street, Edinburgh 2.

BRITISH SOCIETY OF ANIMAL PRODUCTION, 1944-54

FOR many years before the Second World War it had become recognized by scientific workers and practical animal husbandmen that the marginal territory over which both groups move could not be reasonably developed unless means were found of exchanging ideas and experience and of combining them in a scientific approach to problems of animal production. The position in Great Britain differed sufficiently from those in other countries to limit adoption here of precisely the same patterns of organization for this purpose as had been set up overseas; the livestock industries were under less direct governmental and administrative control than in parts of Europe, where bodies with similar aims were in being or contemplated; in the United States the American Society of Animal Production was well established, with a large membership, mainly of scientific workers and advisers, and a long record of valuable published contributions; and, moreover, university departments and research institutes in Great Britain were not so specialized or so opulent, and yet the art and practice of stock husbandry was traditionally on a high plane of achievement.

Again, research workers were more and more tending to present their findings in journals and at meetings so specialized that they were relatively inaccessible to the practical man. Almost as an immediate result of this sectionalization of interests, it was increasingly more difficult for specialists in cognate fields to come together to discuss the mutual inter-relationships of their work, and even more so for the practical stockman to meet the scientist on common ground.

In 1939 the time appeared ripe to form a British organization which might meet local needs and ultimately link up with the European Association then being instituted to foster the wider interests of the existing national societies; and a small group, led by Dr. John Hammond, began to consult with breeders, research workers and advisory officers with this objective. The outbreak of the War imposed delay; but the informal group kept together and by the end of 1943 judged that their ideas could be made more widely known. It was realized that no large membership could be expected for some time, but the response was immediate and enthusiastic. The first meeting was held early in 1944, a constitution adopted, and with Dr. Hammond as its first president, the new British Society of Animal Production began to develop four broad ways of policy.

The first related to reviews of the main sections of the livestock industry, and was in a sense introductory or short-term. By 1944 not only had British animal production been greatly disturbed, with the main emphasis on milk, but also it was clear that difficult problems would appear in any post-war period of readjustment. It is interesting to note from the reports of those earlier meetings, at which the sheep, meat and pig situations were examined, how well the position which was to arise in the late 1940's and these early 1950's was then foreshadowed. That this could be so was largely due to the course taken towards the second line of policy: the founders aimed at securing roughly equal proportions of membership from the scientific, the advisory and the practical fields. It is noteworthy

that such a balance in the roll of members still exists and that each field contributes freely and effectively to the business and vigour of the Society.

A third line of policy was to hold, if possible, two meetings a year: one in London to receive formal papers and discussion; and the second in the Provinces, primarily to provide opportunities of visiting research centres, to view practical developments in animal husbandry, and to consider, on the ground, the livestock industries of the area. This mode of operation still continues, enabling the basic aims of the Society to be firmly expressed. The fourth line of policy was to publish records of the proceedings of the Society in the hope that ultimately the depth and breadth of the volume of progress in the field of scientific animal production in Great Britain would sustain the quality of contributions to a substantial journal. The publication of the "Proceedings" of the Society for 1954 gives an opportunity for reviewing progress made by the Society in the first ten years of its life*.

From the earlier form of reports of meetings, with their records of discussions on the formal papers presented, and accounts of local stock industries and husbandry methods, the first outward development was made in the "Proceedings" for 1952. In that year the serious outbreak of foot-and-mouth disease eliminated the autumn 'local' meeting, so that with no report on it to publish, space was given to an account of the activities of the European Association for Animal Production (to which the Society had attained working membership) and, more significantly in relation to policy, to two contributions on progeny testing—the first being a valuable review of principles and methods by Johansson and Robertson, and the second a critical assessment by Mason of the system and results of bull-progeny testing in Denmark. These papers not only formed an introduction to the central theme of the eighteenth meeting held in 1953, but also added materially to the status of the Society's publications as an essential source of reference to work in the general field.

The 1953 "Proceedings" record a symposium on progeny testing in dairy cattle, pigs, sheep and poultry, together with three special papers on then current research in Scotland, involving feeding experiments with twin cattle, pig research at the Rowett Research Institute, and work by K. L. Blaxter on the relationships of diet to muscular disease in calves.

The next step in policy was taken in 1954 when, at the spring meeting, sixteen papers were given as accounts of work in progress. Compared with the offerings in previous "Proceedings", they form not an orderly sequence of courses but a mixed dish the components of which vary greatly in substance, digestibility and net value, yet which as a whole is appetizing and satisfying as representative of the products becoming available from the further scientific exploration of animal production in Great Britain. Some contributions are given in full, and others only by summary. They range from studies on techniques of weighing grazing animals and the results of winter grazing methods, to comparisons of

* Proceedings of the British Society of Animal Production, 1954. Pp. 116. (Dalketh: Scottish County Press, 1954.) 15s.

breeds and crosses for beef production; from examination of the seasonal changes in management in relation to milk yields to the assessment of progeny test results and to the effects of inbreeding on performance in dairy cattle; from investigations on nutritional levels in late pregnancy, through others on meat quality and on body size in reciprocal crosses, to analyses of the factors of flock size and flock duration in the population genetics of sheep. There are also reports of work on the use of partial records in poultry selection, on the experimental shortening of the generation interval in rabbits by gonadotrophin treatment, and preliminary accounts of comparisons of different sources of vitamins A and D in relation to the fattening of pigs and of X-ray studies on the structure and variation of the vertebral column in the Welsh breed of pigs.

The "Proceedings" are well edited, and appear in pleasing and convenient format: their diffuse contents may suggest that in this step of policy the riser is too high too early in the stairway to the platform of a British Journal of Animal Production. On the other hand, the tread seems sound, and it may well be that the Society can now move up and on to achieve this particular aim, without side-tracking its other aims, of which the study of local methods and practices of animal production is by no means the least valuable and of which all record has been somewhat regrettably omitted for 1953 and 1954.

J. E. NICHOLS

BERLIN ACADEMY OF SCIENCES

THE first 'annual meeting' of the Deutsche Akademie der Wissenschaften zu Berlin to be held since the War took place during March 28-April 2. Until 1939, there had been an annual celebration of the first president of the Academy, G. W. Leibniz. The present meeting was a revival of this tradition. Some four hundred and seventy scientists from Eastern Germany and some eighty scientists from other countries, including Western Germany, took part in the meetings.

The opening session was held in the Grosser Festsaal im Haus der Ministerien and was addressed by the president of the Academy, Prof. W. Friedrich, well known as the co-discoverer, with von Laue and Knipping, of the diffraction of X-rays by crystals. Government representatives present included the president of the Volkskammer, Dr. Dieckmann, and the Prime Minister, Otto Grotewohl. After Dr. Friedrich had spoken, each of the secretaries of the five sections of the Academy reported on his own section. Last year a considerable reorganization of the Academy took place so that the subjects are re-grouped in the following way: (1) mathematics, physics, engineering; (2) chemistry, geology, biology; (3) medicine; (4) language, literature and art; (5) philosophy, history, law, economics. (The inclusion of non-natural science subjects within the purview of the Academy follows a common Continental custom of using the word science in the meaning of 'scientias'.) The secretaries' reports all showed a very considerable development of the work done by the various institutions and laid stress on the need for ensuring a proper application to industry of the results of scientific research. The present secretaries of the sections are, respectively, Profs. Rompe, Noack, Lohmann, Frings and Unverzagt. The second full

session was addressed by Prof. Kurt Mothes on "The Roots of Plants—a Chemical Factory of a Particular Kind", and by Prof. Wolfgang Steinitz, vice-president of the Academy, on "Songs and Fables as Expressions of the Spirit of a People". Then followed two and a half days of conferences on specialized subjects. These included "Physics and Chemistry of Crystals", "Metallurgy of Iron", "Radio-astronomy", "Fibres from Synthetic High Polymers", "Results and Problems of Biochemical Research", "Questions concerning Cancer Research and Treatment", "Dialect Study", "Songs, Fables, Proverbs and Sayings, as expressions of the Spirit of a People". There were also lectures by Prof. Gordon Child (London) and Prof. Hans Jürgen Eggers (Hamburg) in the Institute for Pre- and Early-History, and by Prof. Johannes Straub (Bonn) in the Commission for Spätantike Religionsgeschichte. Visits were arranged for all the visitors to the laboratories and institutions in which they were interested. An informal reception was arranged on the first evening and a dinner party in the great hall in the Haus der Ministerien at the conclusion of the meetings. A two-day excursion to Weimar, famous for its associations with poets, was arranged for those who had time to go.

Certain general impressions may be worth recording. The scientific institutions and those who work in them are flourishing; the material means both in terms of research facilities and salaries are good. There is a widespread desire for more contact with scientists in other countries, and a wish to be able to attend international conferences more easily than is possible at present. The publications of the Akademie Verlag include a considerable number of translations of important modern Soviet books, and for those who cannot read Russian the German Academy is likely to be of great service through those translations. Finally, it should be said that the friendliness and hospitality shown by our hosts were all that could be desired.

W. A. WOOSTER

NATIONAL SCIENCE FOUNDATION, WASHINGTON, D.C.

REPORT FOR 1953-54

THE fourth annual report* of the National Science Foundation, Washington, D.C., covers the year ended June 30, 1954, and includes, besides the report of the director, Dr. A. T. Waterman, a foreword by Chester J. Barnard, chairman of the National Science Board, and appendixes listing the personnel of the Board and its advisory panels and committees and the basic research grants made during the year, as well as a complete list of individuals awarded fellowships in 1954. Mr. Barnard emphasizes in his foreword that the central task of the Foundation is the promotion or cultivation of science in the United States, and in this connexion notes the importance of incentives for the pursuit of scientific careers. A deep, personal and indefatigable interest in scientific discovery is the primary and indispensable incentive; but relative freedom, adequate remuneration and public esteem are also important, and lavish and indiscriminate expenditure will not counterbalance conditions which discourage initiative, imagination

* National Science Foundation. Fourth Annual Report for the Fiscal Year ending June 30, 1954. Pp. ix+138+4 plates. (Washington, D.C.: Government Printing Office, 1954.) .50 cents.

and persistence. Wisely administered programmes of scholarships and fellowships are invaluable for encouraging the development of scientific workers, and this, as well as the acquisition of scientific knowledge, are the main purposes for the Foundation's support of research.

During the year ended June 30, 1954, the Foundation made 374 grants, totalling 3,888,220 dollars, for the support of basic research in the natural sciences, compared with 269 grants, totalling 2,751,912 dollars, in the previous two years. Of these, 177 (totalling 1,929,470 dollars) were in the biological and medical sciences and 197 in the mathematical, physical and engineering sciences, and during the past year the Foundation has assumed the primary responsibility for Federal support of basic research in radio-astronomy, pure mathematics, low-temperature research, systematic biology and ecology. Special attention is directed to the Foundation's support of work on the utilization of high-temperature energy and low-level or solar energy, on meson physics, Hilbert space, luminescence, steroid chemistry, archaeology, and on the history, philosophy and sociology of science. In March 1954 the Foundation announced the award of 657 fellowships and 79 post-doctorate fellowships for advanced study in the natural sciences for the year 1954-55. Of these, 213 were in the biological sciences, 171 in chemistry, 92 in engineering, 33 in the terrestrial sciences, 72 in mathematics and 155 in physics and astronomy. The programme of regional summer institutes and conferences for science teachers was extended, and four such conferences were held; conferences on solid-state physics in engineering education and on nuclear physics in engineering education were also arranged to assist the inclusion of some of the more recent advances of science into the engineering curriculum, while the Foundation also sponsored an experimental summer conference for high-school mathematics teachers.

During the year the American Institute of Physics, at the request of the Foundation, initiated an inquiry to determine the desirable limits of a plan for improving the coverage, abstracting and translation of important current reports on physics research in the Soviet Union. Areas in which complete English translations of Soviet physics journals are particularly desirable are molecular spectroscopy, magnetism, low-temperature physics, underwater sound and related applied acoustics, solid-state physics, non-linear mechanics and differential equations. The Foundation continues to support the American Mathematical Society's programme of translating Russian mathematical papers and, with the Atomic Energy Commission, to sponsor the collection and listing, by the Scientific Translation Centre of the Library of Congress, of scientific translations from periodicals of the U.S.S.R. The Foundation has also now established the criteria to be used for evaluating requests for financial assistance to scientific publications, and during the year travel grants were approved to 101 American scientific workers to enable them to participate in some twenty-five international scientific meetings.

A special feature of the work of the National Science Foundation is its sponsoring of conferences in special areas of science. In this way the Foundation is able to encourage research in fields of potential national interest but for which industrial support is not available. Jointly with one or more private or public agencies, including the universities and

scientific societies, the Foundation supported nineteen such conferences during the year. They included those at Lowell Observatory on photoelectric problems, techniques and instrumentation for astronomical research; at Northwestern University, Evanston, on the present status of position measurements of celestial bodies; with the University of Wisconsin on the utilization of solar energy; with the University of Chicago on nuclear processes in geological settings; and with the Columbia University on the role of proteins in the transport of ions across membranes. A symposium on glutathione research was sponsored jointly with Columbia University and the Office of Naval Research, and an international conference on cosmic ray research with Duke University, while the Foundation also joined with the Rice Institute, Houston, Texas, and the International Union of Pure and Applied Physics in sponsoring the Third International Conference on Low Temperature Physics and Chemistry. In co-operation with the American Academy of Arts and Sciences, the Institute for the Unity of Science and the American Association for the Advancement of Science, the Foundation supported a conference on the validation of scientific theories; one on radio-astronomy, with the Carnegie Institution of Washington and the California Institute of Technology; on high-speed computing in meteorology and oceanography, with the University of California; on multi-dimensional analysis in psychological research, with the University of Michigan; and on present-day theories of liquids and the use of acoustical methods in studying the structure of liquids, with Brown University. The Foundation also sponsored a conference on the luminescence of biological systems and symposia on physiological development of the mammalian foetus, with the Long Island Biological Association; on development and growth, with the National Institutes of Health, the Society for the Study of Development and Growth, and Dartmouth College; as well as conferences on problems in human communication (with the Massachusetts Institute of Technology) and, with Cornell University, on fundamental problems of perception.

Details are also given in the report of the proposed United States programme for the International Geophysical Year in 1957-58, in which the Foundation is responsible for co-ordinating the Federal interests and handling the fiscal and administrative planning for the United States Government. For the rest, the director's report makes it plain that the preoccupations of the Foundation are similar to those of the Advisory Council for Scientific Policy or the Lord President of the Council in Great Britain. The importance of a clear understanding of what science is about, particularly in view of a Federal expenditure on research and development of more than two thousand million dollars, more than 90 per cent of which is for applied research and development, is emphasized. There is concern over the effect of technological and military secrecy on scientific work and the recruitment of scientists; in the United States, as in Great Britain, there is concern over the output of scientific workers, as well as their utilization, and over a shortage of science teachers, and there is no evidence that the loss of science doctorates, estimated at nine thousand during 1942-49, will be made up. Concern is expressed also over the extent to which physics research is pursued in colleges, and the Foundation is making a series of studies of research at educational and other non-profit institu-

tions; the research programmes of Federal and State Governments; surveys of research at non-profit institutes and by commercial laboratories, by trade associations and similar organizations; and industrial research and development in general.

NATURAL PERMANENT MAGNETIZATION OF THE LOWER BASALTS OF NORTHERN IRELAND

A PAPER by J. Hospers and H. A. K. Charlesworth (*Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 7, 1; October 1954) gives the results of investigations on the natural permanent magnetization of the so-called Lower Basalts of Northern Ireland. It has been known for at least a hundred and fifty years that eruptive rocks have a permanent magnetization which is much larger than can be acquired in the present geomagnetic field at 20° C. Moreover, evidence from various sources confirms the view that the natural direction of magnetization of an igneous rock is the same as that of the local geomagnetic field at the time of its solidification, allowance being made for subsequent tectonic movements. Hospers has recently published the results of his investigations of the history of the geomagnetic field in Iceland from Miocene times to the present day—that is, during the past twenty million years—and has shown that the natural permanent magnetization of the Icelandic lava flows originated when these flows cooled down after their extrusion. A similar investigation was undertaken in Northern Ireland, and in the paper under review Hospers and Charlesworth show by means of a diagram the extent of the Tertiary plateau basalts and the localities where samples were taken.

The cylindrical specimens of known orientation, a hundred and twenty altogether, were measured on a simple astatic magnetometer, the technique of which was described by J. Hospers in "Palaeomagnetic Studies of Icelandic Rocks" (Ph.D. thesis, University of Cambridge, 1953). Corrections to the resulting directions were afterwards applied for the geological dip of the strata, and the final directions were thus obtained, expressed in declination relative to geographic north and in inclination relative to the horizontal plane, both at the point where the samples were taken. The uncertainty in the final directions is discussed under two headings—uncertainty in the declination and uncertainty in the direction in space—and as a result of this discussion it appears that the maximum possible angle between different samples from the same flow consistent with homogeneous magnetization of the sampled part amounts to approximately 20°; as the angle between the directions of samples from flow O6 (Evish, $\frac{3}{4}$ mile east of Milltown, Co. Antrim) are smaller than this, the magnetization is almost certainly homogeneous.

A reverse magnetization in all lava flows that have been studied has received a considerable amount of attention in recent years, and various explanations have been offered for it. One is that it is due to the physical properties of aggregates of ferromagnetic minerals which produce reverse magnetization on cooling in a field which had essentially the same direction as the present field, while other explanations invoke reversals of the local or the main geo-

magnetic field. In analogy with the results obtained by Hospers, from his study of Icelandic plateau basalts (published in *Proc. Kon. Ned. Ak. Wet.*, 56, 467, 477 (1953); 57, 112 (1954)), there are strong reasons for assuming that the permanent magnetization of the Northern Ireland plateau basalts originated when these flows cooled down for the first time after their extrusion, and also that the direction of magnetization has been stable since that time. There is a short discussion of the 'polar wandering' hypothesis against which there are various arguments; but it is admitted that some of these lose their force if the Lower Basalts of Northern Ireland are much younger than Eocene times, and some authorities believe that they may be Late Miocene and Early Pliocene. The matter is still open to considerable doubt.

TIME-SCALE OF THE UNIVERSE

DR. E. J. ÖPIK, of Armagh Observatory, has greatly expanded and supplemented his essay on "The Age of the Universe", which he originally submitted for the competition on this subject arranged by the Philosophy of Science Group of the British Society for the History of Science and which was published by the Society (*Brit. J. Phil. Sci.*, 5, No. 19; November 1954; see also *Nature*, 175, 68; 1955). The new article, which is published in the *Irish Astronomical Journal* (3, No. 4; December 1954), provides a very full account of various changes in cosmologists' conceptions of the age of the universe.

The long time-scale—a multiple of a million million years—was largely due to Jeans's investigations into the statistics of stellar motions and also the distribution of the orbits of double stars. The fallacies in his original assumptions are pointed out; in addition, while Jeans carefully considered the effects of encounters on close binaries, he ignored the effects on wide pairs and star clusters. Yet, on his own theory, the effects on the latter should have been thousands of times stronger than the effects on the former. Overwhelming evidence against statistical 'gas-kinetic' equilibrium was a serious blow to the long time-scale, and the fundamental fact requiring a short time-scale—the red-shift of the extragalactic nebulae—"was like a bombshell amidst the complacent 'permanentists'".

The misleading evidence derived from radioactive determinations of the age of meteorites and from investigations in other directions is carefully dealt with in the paper. Some recent views are considered, as, for example, that of continuous creation, the acceptance of which would dispense with a finite age for the universe. Öpik dismisses them rather summarily with the remark "... these theories can at present be assessed only from the standpoint of their aesthetic value. It is not easy to imagine observational criteria for them which cannot be explained away". His conclusion is that the combined evidence from a number of more-or-less independent sources leads to the view that the age of the universe in its present form and content does not exceed 6,000 million years. The extragalactic nebulae and also our galaxy, with its backbone of Population ii stars, may have been formed about 4,500 million years ago; the sun as a star of Population i may have come into existence later.

Öpik conjectures that what we now see may be only the metagalaxy—merely a step in the hierarchy of physical systems—and that the observed expansion may refer only to this limited, although large, material system; conditions may be different in other parts of the universe. In the case of closed space, the universe (either the whole or the observable metagalaxy) must inevitably return to the initial state of nuclear fluid, and the universe would oscillate without external loss, “implying an unlimited age in the past and in the future”. While some have expressed disgust at the idea of an oscillating universe, Öpik cannot see why it should claim a less æsthetic value than the annual succession of seasons, so praised by poet and layman.

EFFECT OF INCLUSIONS ON STEEL

THAT the mechanical properties of test pieces of steel cut transversely to the direction of working are inferior to those cut longitudinally has been recognized for very many years. Further, it is implicit in many specifications that the process by which a steel has been manufactured exerts its influence on the properties. It is well recognized that the inclusions present play a substantial part in determining the difference of properties in the transverse and longitudinal directions; but it may be doubted whether the mere presence of such inclusions could of itself offer an adequate explanation of all the facts. Why the steelmaking process should have an influence is still a matter largely of speculation, though the gases present—oxygen, hydrogen and nitrogen—and their amounts have been suggested as playing a predominating part.

The Iron and Steel Institute, in Special Report No. 50, has published a paper by Mr. P. H. Frith, on “Fatigue Tests on Rolled Alloy Steels made in Electric and Open-Hearth Furnaces”*, which forms a report of the Fatigue and Inclusions Committee of the British Iron and Steel Research Association. A part of this work was carried out under the auspices of the Inclusions Sub-Committee of the Iron and Steel Institute, formed in 1936, at the instigation of the late Dr. W. H. Hatfield, to investigate the practicability of measuring the standard of cleanliness of aircraft steels by means of some numerical count. It was soon apparent that the grading of steels by this inclusion count method did not necessarily coincide with that based on mechanical properties, and an extensive programme of fatigue tests has been carried out, mainly by the Bristol Aeroplane Co., Ltd. An enormous amount of work has been put into this investigation, which, in some directions, is one of the most important contributions to our knowledge of the factors determining the properties of steel for very many years.

The steels examined were heat-treated to give tensile strengths of 60–110 tons/sq. in. Up to the former strength, the inclusions of the size and type normally present do not appear to exert any particularly detrimental effect, though accidental inclusions of more massive form are probably harmful. As the strength of a steel is increased, however, the effects of the inclusions grow progressively more serious, particularly in reducing the resistance to

fatigue. One of the most outstandingly important observations made during the course of this work seems to be the profound influence exerted by the shape and deformability of the inclusions, which therefore are divided into three groups: (1) those which deform during hot-working and become elongated; (2) those which do not deform; and (3) those undeformed inclusions of Group 2 which have a deformable envelope of manganese sulphide.

From the point of view of the stress concentration which results, it is believed that the undeformable inclusions of Group 2 are those which are most detrimental to the fatigue properties. These include hard angular fragments of alumina or aluminosilicates, titanium cyanide-nitride, quartz and spherical silicates. It also appears from these tests that, in any event up to 0.04 per cent sulphur, the fatigue properties are not affected by the number of manganese sulphide inclusions so long as this sulphide does not form part of a duplex aggregate. This emphasis on the importance of the plastic properties of the inclusions is supported by the fact that the reduction in the fatigue limit in the transverse direction cannot be directly correlated with the sulphur, oxygen or phosphorus content of the steel, either singly or combined.

In addition to the normal metallographic examination, microradiographs, magnetic tests, etc., were also employed, the importance of the first of these lying in the fact that, although the surface inclusions appear to play no particularly harmful part, there is good evidence that inclusions lying just below the surface, for some reason or other, may, and apparently often do, act as the starting-point for fatigue cracks. In certain steels, particularly basic electric, inclusions of an apparent diamond shape are not uncommon. Careful investigation has shown that the actual inclusion in such cases is itself more or less spherical, but that during the working operation ‘cavities’ are formed in front and behind, and these apparently may play a profound part in initiating fatigue. It would appear, therefore, that we have here at any rate a partial explanation of the influence of the steelmaking process employed, since open-hearth steels appear to be less prone to contain these hard spherical inclusions than is that made by the basic electric process.

The author has spent many years on this work and he and the Bristol Aeroplane Co., Ltd., deserve most sincere thanks for the light which is thrown on a problem of the greatest importance to all those who make and who use the higher-tensile steels.

F. C. THOMPSON

STANDARDIZATION OF WOUND TEXTILES

By DR. HEINZ BARON

Surgical Clinic of the Medical Academy, Düsseldorf

AS a preliminary to any discussion on the standardization of wound textiles, a brief discussion is necessary as to whether wound textiles are, in fact, true healing agents. My own work has shown that suppuration and cedema of the surrounding tissue results when a wound is covered by a ‘Plexiglass’ capsule (Baron) (see Figs. 1a and 1b: the wound rises into the hollow space of the capsule). The effect is

* Iron and Steel Institute Special Report No. 50: Fatigue Tests on Rolled Alloy Steels made in Electric and Open-Hearth Furnaces. By P. H. Frith. Pp. vii + 130 + 22 plates. (London: Iron and Steel Institute, 1954.) 25s., or 15s. to members of the Institute.

similar to 'window' edema which often results when openings are made in plaster of paris casts and can be termed 'hollow compression'. If, however, sixteen layers of gauze or eight layers of cambric are placed on the wound and the capsule then applied, 'plane compression' results (Fig. 2). The open-air treatment of wounds and burns which is so often praised has been found to be less favourable for the wound than the immediate application of a textile which is as free of irritation as possible. It can be shown by animal experiments that the mortality-rate decreases with the covering of the wound, and that the healing of the central piece of skin in the standard ring wound (Baron) can take place with only very little or no shrinkage (that is, without the loss of tissue), with the result that the cicatrization is better from the cosmetic point of view than is the case in the healing of the wound in the open air without a wound textile. These results apply only to ring wounds with a 90 per cent loss of connective tissue. Wounds of a more superficial type form their own wound cover by natural processes within thirty minutes and may not require covering by textiles. One therefore arrives at the following fundamental conclusions for the process of healing wounds: (1) open-air (in the sense of the so-called 'open') treatment of wounds is disadvantageous for deep wounds, but without any harmful influence on superficial wounds; (2) plane compression (for example, by means of a plate of 'Cellophane') will eliminate the harmful effects of the hollow compression because the plane compression will avoid congestion; (3) textile drainage allows the removal of the wound secretion with simultaneous plane compression, so that a suction effect occurs in the wound textile; this effect eliminates the harmful influence of a moist chamber; (4) unfavourable effects due to localized forces, for example gravity, in the tissue are diminished to a considerable extent by plane compression and textile drainage; (5) a delay of 6-8 hr. in covering a wound leads to serious disturbances in the healing, as is shown by the considerable increase in the mortality-rate of experimental material.

Three methods of making wound textiles are in common use: weaving (two threads, warp and weft), knitting (one thread) and fleecing. Fleecing consists of a space structure whereby the material is woven together in all directions in space and, in contrast with felting, no binder is used. Weaving is the most common process used for the production of wound textiles, and, in this connexion, the warp plays the decisive part. In our first experiments we kept the

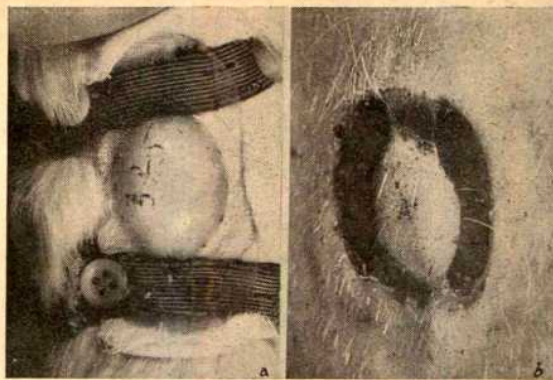


Fig. 2. Standard ring wound (a) covered by gauze, (b) without dressing; note no suppuration, no congestion and good blood supply

warp constant at 'metric 60', and selected a weft yarn of 'metric 80', thereby obtaining a typical gauze (Fig. 3a), and also a weft of 'metric 20', which gave us a cambric fabric (Fig. 3b). The effect of sixteen layers of gauze is equalled by that of eight layers of cambric. Although the price of gauze is lower per yard, it is more expensive in use, since sixteen layers of gauze cost about 50 per cent more than eight layers of cambric; however, the absorptive power of cambric is inferior to that of gauze. The difference in absorptive power between cambric and gauze becomes especially evident if one compares eight layers of cambric with eight layers of gauze. In the case of cambric, the wound secretion is confined to a limited area, whereas under gauze it tends to spread far into the neighbourhood. This is the case even if sixteen layers of gauze are used, though, of course, the secretion spreads less than under eight layers. An interesting observation was that sixteen layers of cambric had a more adverse effect on the healing process than sixteen layers of gauze. As the cambric fabric is thicker and heavier, it interferes with the ventilation of the wound, which then becomes soggy or wet.

Our experiments show convincingly that the indiscriminate choice of wound textiles without regard to the number of layers used or the character of the fabric may not only prove uneconomical but may also be harmful to the wound. Selection of wrong wound textiles also affected the mortality-rate in our experimental animals. When using eight-layer cambric or sixteen-layer gauze compresses weighing 3 gm. each, the mortality-rate was 23 per cent. Animals with wounds on both sides, which were covered with eight-layer cambric compresses weighing 3 gm. each, one compress being moistened with 10 c.c. of water, showed a mortality-rate of 27.5 per cent. When the wound on one side of an animal was covered with an eight-layer gauze compress weighing 1.5 gm., the wound on the other side having an eight-layer cambric compress of 3 gm., the mortality-rate increased to 36 per cent. Although differences in the duration of the healing process were insignificant between the two kinds of compresses, the increased mortality-rate shows that the susceptibility to infection is greater under the eight-layer gauze compress owing to the spreading of the secretion underneath.

A different picture is obtained when an eight-layer cambric compress weighing 3 gm. is compared with a sixteen-layer cambric compress of 6 gm. The latter

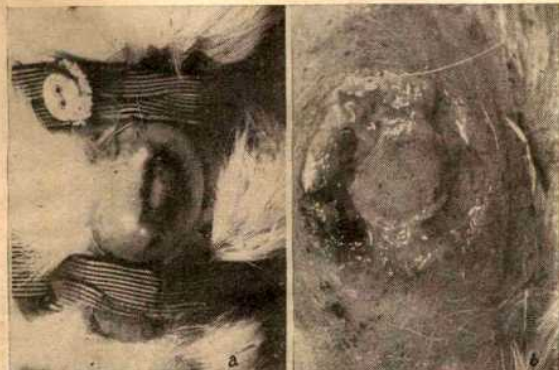


Fig. 1. Standard ring wound covered by moist chamber. Note in (b) suppuration, moisture and congestion

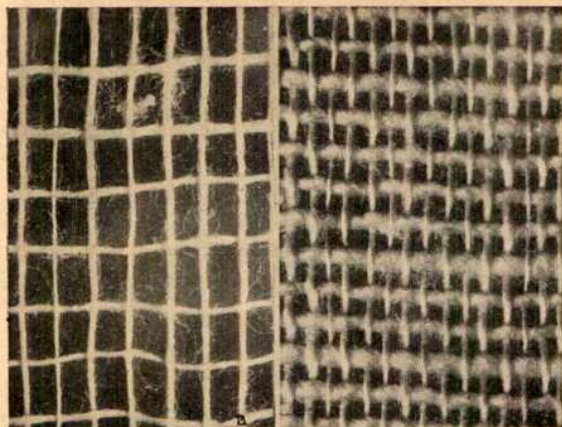


Fig. 3. (a) Gauze, a two-dimensional textile; (b) cambric, a three-dimensional textile

has an unfavourable effect on the healing of the central area due to lack of evaporation, the mortality-rate being 31 per cent. The influence of moisture is especially marked if evaporation is inhibited by covering the textile with a waterproof fabric. The central area heals with a small loss of tissue. The increased susceptibility to infection due to the lack of evaporation is shown by frequent suppuration of the wounds, and the mortality-rate rises to 40 per cent. The influence which delay of treatment exerts on the mortality-rate is especially impressive. The healing process is significantly slowed down, the central area heals with loss of tissue due to infection, and the mortality-rate rises to more than 50 per cent. This makes it clear that the first condition for successful treatment with wound textiles is to avoid delay and to dress the wound as quickly as possible.

We have been able to show that evaporation plays a decisive part in the successful application of a wound textile. Moistening of a wound textile under conditions when evaporation is uninhibited may be quite harmless. This, however, is not always the case. Moistening of the fabric might have an unfavourable effect on the wound in the case of certain textiles. For example, if very densely woven linen is moistened, it becomes still denser through swelling of its fibres. Though such fabric, through its strong absorptive power, may produce a quick drying effect, this effect soon reaches its peak and after that no further absorption takes place. The fabric lies on the wound like a wet cloth. Textiles made from cellulose wool by a fleecing process have a good drainage effect through capillary attraction when they are dry; when, however, such a fabric is like wet blotting paper, its effect on a wound is similar to that obtained by the application of textiles that inhibit evaporation.

In the assessment of wound textiles, it is advisable to sub-divide them into two-dimensional and three-dimensional textiles. The former group includes gauzes and woven linen materials, and the latter group embraces cambrics as well as all fabrics with appreciable differences in the yarn thicknesses for the warp and the weft and also knitted textiles. The use of thicker yarns decreases the number of layers.

The practical considerations to be drawn from these findings are as follows. In view of the fact that three-dimensional fabrics have been found to be the most suitable, thicker threads should be used for the making of wound textiles than have been used

hitherto. The number of threads per unit length should be neither too great nor too small, for if the texture of the fabric is too dense, swelling of the fibres may close the interstices between the threads and the effect on the wound might be similar to that produced by an impermeable material. The two necessary properties for a wound textile are resistance of the fabric to shrinkage and shearing and the avoidance of adhesion with the surface of the wound. Shrinking is of two forms: primary shrinking, which takes place immediately the fabric is immersed in a liquid, and secondary shrinking, which occurs during the drying of the fabric. Primary shrinking has no significance in the treatment of wounds if the fabric is placed on the wound in a wet state, but secondary shrinking has an important influence on the healing process. A figure of 10 per cent shrinking or more has been measured for fabrics during drying; if, therefore, a fabric that is placed on a wound in the wet state dries out, movements in the area of the wound will occur which may cause pain and irritation of the wound and its surroundings. The extent of these movements may be of the order of five hundred times the size of a tissue cell. It is small wonder, therefore, that plastic surgeons prefer the open-wound treatment for Thiersch and Reverdin grafts. Whereas wound textiles made of cotton and bought on the open market show considerable shrinkage, specially made wound textiles of cellulose wool are found to be shrink-resisting.

The problem of resistance to shearing forces has yet to be solved for gauze. Owing to its loose texture, movements of the threads within the fabric take place continuously, which is not the case in cambric fabrics. After use, cambrics show only insignificant changes in the position of the threads within the fabric caused by the drying of wound secretions. In contrast, loosely woven gauze is sometimes completely destroyed in parts by the drying secretions. Shrinking through drying and lack of resistance of the fabric to shearing forces are factors which operate against one of the basic requirements of wound treatment, namely, immobilization. It should therefore be our aim to create wound textiles that remain static. The extent of shrinking and, with it, of movement within the fabric may vary locally inside the area of a wound. That is perhaps a possible explanation for the fact that sometimes we observe a sudden localized deterioration of part of a wound.

The problem of the adhesion of the wound textiles has not yet been solved. All experiments on the impregnation of fibres with the aim of eliminating adhesion have failed, no matter how logically they were built up. The crude fibre has in any event a tendency towards adhesion similar to a processed fibre. The wax-pectin layer is usually removed from crude fibres through the steeping process, and, in order to eliminate the adhesion thereby caused, unnecessary attempts are made to compensate for the removal by impregnating the fibres with carbo-waxes. Why should the steeping process not be carried out less drastically, leaving some of the wax pectin? Experiments have shown that the crude fibre has a favourable influence on the beneficial effect of penicillin applied externally, as well as being generally favourable to wounds in other respects as well. The demand for a satisfactory absorptive power which is always being emphasized may also be a cause of irritation to the wound. This is shown by numerous experiments made on the comparative merits of raw cotton and finished cotton

applied immediately to a wound. It has been found that all wound textiles have a detrimental influence on the wound when their application is delayed by as little as 6-8 hr. The infections which result thereby may be countered by the external use of penicillin. All finishing processes for wound textiles should be studied from the pharmacological and toxicological points of view. This applies particularly to cellulose wool, as the crude form, which has a yellowish tinge and is glossy, has been proved to have a most favourable influence on wounds; both matting with titanium dioxide and brightening with optical whiteners are frequently the cause of irritation to the wound. Even the diemoptical whitening of the crude cotton fibre has been proved to have disadvantages when used as a wound dressing; that is the reason for dispensing, from a surgical point of view, with a washing powder which contains optical whiteners.

Accordingly, all processes should be dispensed with which no longer have any scientific foundation, but rather only serve to make the fabric more pleasing to the eye of the purchaser. An unlimited new field offers itself to wound research: from among the numerous types of natural fibres or the more readily studied variations of synthetic fibres, the best fibre must be sought out and then processed into a wound textile with the most suitable yarn thickness and position of the threads. Only the best is good enough for the patient. This can only be achieved by strict standardization of products. At present in Germany no standardization exists.

ARTIFICIAL PRODUCTION OF IMMUNOLOGICAL TOLERANCE

Induced Tolerance to Heterologous Cells and Induced Susceptibility to Virus

IN 1949 Burnet and Fenner¹ postulated that antibody production against a particular antigen can be specifically suppressed by exposure to the same antigen during embryonic life. The first demonstration of this effect had already been given by Owen². He found that dizygotic calf twins, which had long been known during foetal life to possess vascular anastomoses between their placentae, con-

tained after birth a mixture of two sorts of blood cells, one corresponding to its own genotype and the other corresponding to the genotype of its twin. The persistence in later life of this blood-cell mosaic could clearly only be explained by assuming that haematopoietic cells transplanted during foetal life failed to provoke the antibody response which is the usual response to homotransplantation of living cells. The next important contribution was that of Medawar, Billingham *et al.*³, who showed that such binocular twins several months after birth were also tolerant to mutually exchanged skin grafts. The tolerance to skin was sometimes only partial; but in most cases was described as complete. Neimann-Sorensen, Gammeltoft and Simonsen⁴ later showed that even a whole kidney transplanted from one cattle twin to the other of a pair which had a typical blood-group mosaic functioned for five months.

The decisive step which brought the principle of immunological tolerance from the sphere of Nature's eccentricity into the domain of an experimental method of possibly very wide applicability was the artificial production of a similar type of tolerance. This was done by Billingham, Brent and Medawar⁵ and by Hašek⁶. The former group of workers injected chick and mouse embryos with living homologous cells and showed that these were able in post-natal life to accept skin grafts from the original donors. Hašek developed a method of producing parabiosis of avian eggs through the chorioallantoic membranes, and showed that chicks so treated during embryonic life failed to respond with antibody production when later challenged with each other's blood.

The present investigations were carried out on birds by the method devised by Billingham, Brent and Medawar, and had a threefold purpose: (1) investigation of whether tolerance could be acquired to cells of foreign species; (2) if so, whether the tolerance would also extend to a virus from the donor animal to which the recipient was not normally susceptible; (3) whether a sexual cross between species which is not normally possible could be made so by means of acquired tolerance. Positive answers to the first two questions have been obtained; the answer to the third awaits the sexual maturation of the treated birds.

Chick embryos (Brown Leghorn) were injected intravenously with blood from adult turkeys or geese, and turkey embryos (American Mammoth Bronze) with adult chicken blood. Natural agglutinins occur

Table 1

Exp.	Recipients	Donor	T_1 Titres before immunization (range)	T_2 Titres after immunization (range)	Individual values of T_2/T_1	Significance of difference between means of $\log T_2/T_1$ for experimental and control groups (evaluated by the <i>t</i> -test)
I Injected in the egg (I)	Chicken 5	Turkey	2-16	2-32	4 1 2 1 2	$t = 3.08 \quad 0.01 > P > 0.001$
	Normal controls 12		4-32	16-512	8 16 4 64 4 4 2 4 32 4 8 16	
II Injected in the egg (II)	Chicken 8	Goose	$< \frac{1}{2} - 64$	32-512	2 4 128 2 64 4 128 2	$t = 1.29 \quad 0.3 > P > 0.2$
	Normal controls 14		$< \frac{1}{2} - 64$	32-1,024	16 64 64 128 16 128 16 32 128 16 256 32 32 32	
III Injected in the egg (III)	Turkey 6	Chicken	2-8	2-32	8 1 1 1 2 1	$t = 3.21 \quad 0.01 > P > 0.001$
	Normal controls 7		2-8	8-128	4 32 8 16 16 2 4	

Antibodies in Exp. I and II were determined after one immunizing injection, in Exp. III after two injections

endothelial system. According to Burnet and Fenner, a similar inability to form antibodies can be provoked by even a foreign antigen entering the reticulo-endothelial system during this stage. The experiments of Burnet, Stone and Edney³, in which living influenza virus A, bacterial virus C 16 and human erythrocytes were introduced into chick embryos, did not confirm their hypothesis. In agreement with the theory are, however, the findings of Owen⁴ in respect of bovine twins. In the case of twins this phenomenon is due to placental anastomosis, that is, to natural embryonal parabiosis.

We have worked out a method of experimental embryonal parabiosis in birds⁵. Incubated eggs are used at the stage (chick 8–12th, duck 10–15th day of incubation) when the chorioallantoic membrane has begun to occupy most of the space under the shell. At the pointed end of the egg, where the major allantochoionic vessels ramify, an oval hole, 1–2 cm. in diameter, is drilled. After removing the greater part of the shell membrane underlying the hole, a small piece of embryonic tissue (usually the blastoderm of an egg incubated 20–40 hr.) is applied to the exposed chorioallantoic membrane and another egg with a corresponding aperture is applied on the other side. The junction is fastened by paraffin wax. The joined eggs are further incubated and turned in the normal way. As it is the extra-embryonal circulation which is connected, the parabiosis is interrupted at hatching. We confirmed the exchange of blood by the detection of the partner's erythrocytes in the blood of the parabiont by agglutination tests immediately after hatching. The degree of exchange can thus be quantitatively evaluated.

We found that no antibody production could be elicited by reciprocal immunization of adult chicks which had been joined during their embryonic development by parabiosis, whereas any normal chick immunized by the erythrocytes of any other chick forms isoagglutinins⁵. These parabionts do not, however, lose the ability to form isoagglutinins when immunized by erythrocytes of chicks other than their partner. By the absorption of the iso-immune serum prepared in a third bird against erythrocytes of one of the partners with the erythrocytes of the other, it has been demonstrated that the antigen composition of the erythrocytes of the two partners differs. In this respect, they differ from bovine natural embryonal parabionts, in the blood of which erythrocytic mosaicism persists. They also differ in another respect: they are fertile, as our two pairs of heterosexual parabionts show. We are endeavouring to find how long this suppression of reactivity lasts. In one of our pairs, in which immunization had initially failed to provoke antibody formation, one two-year-old parabiont formed agglutinins against the partner's erythrocytes after the fourth immunization, whereas its partner did not. Similar results with respect to the experimental suppression of immunobiological response have been described by Billingham, Brent and Medawar⁶ with respect to skin transplantation in mice and chicks. We have confirmed their results by skin transplantation in chick parabionts⁷.

In interspecific embryonal parabionts between chick and duck, an inability to form antibodies was not found. In all individuals of both species there are natural heteroagglutinins against erythrocytes of the other species. In parabionts these natural antibodies invariably appeared in the same quantity as

in controls. When immunizing adult individuals in their first year of life, antibodies were also formed in both parabionts—in chicks in the same quantity as in the controls (Table 2), and in ducks in a smaller amount (Table 1; see also ref. 8). Each figure in the tables represents the titre of an individual; animals in one line (parabionts and controls) were immunized by the same donor. In contrast to the parabiosis between the chicks, it made no difference whether the immunization was performed by erythrocytes of the parabiotic partner or of any other individual.

Table 1. TITRES OF IMMUNE AGGLUTININS AGAINST CHICK ERYTHROCYTES IN DUCKS

Parabionts	Controls
2*	32† 64, 32
4*	32, 64
8*	256
4, 8	128, 128
4	32, 8
64†	64
	32, 64

* Animal immunized by erythrocytes of embryonal parabiotic partner.

† Parabiont in which the exchange of blood was excluded by agglutination test.

‡ Exchange of blood not unequivocally demonstrated.

All parabionts or their partners were tested by agglutination immediately after hatching for the exchange of erythrocytes.

For earlier material, in which embryonic erythrocyte exchange was not tested, see Frenzl *et al.* (ref. 8).

Table 2. TITRES OF NATURAL (IN PARENTHESES) AND IMMUNE AGGLUTININS AGAINST DUCK ERYTHROCYTES IN CHICKS

Parabionts	Controls
64 (16), 256 (32)	64 (4), 64 (8)
128 (2)	128 (2)
256 (8)*, 256 (1)	256 (8)
512 (4)*†	128 (16), 1,024 (2)
128 (2)	128 (2)

* Represents an animal immunized by the erythrocytes of its embryonal partner.

† The skin of the duck partner was transplanted on the fifth day after hatching, the transplant surviving sixteen days.

All parabionts have been tested by agglutination immediately after hatching with respect to the exchange of erythrocytes.

We thus succeeded in causing an absolute suppression of antibody formation only by the action of homologous blood cells during embryogenesis. Heterologous blood cells did not have this effect. We obtained similar results in our embryonal parabionts with skin heterotransplantation⁷. We are continuing to study the problem of whether the antigen which is able to suppress the formation of antibodies must be of the same species, or whether this effect eventually can be obtained by the antigen of a foreign but phylogenetically related species. We are investigating this problem on chick–turkey and chick–pheasant embryonal parabionts. In any event, our results prove that in complete suppression of antibody formation caused by exposing the embryo to a foreign antigen, the character of the antigen is of importance. This fact was not taken into consideration by Burnet and Fenner.

M. HAŠEK
T. HRABA

Institute of Biology,
Czechoslovak Academy of Science,
Prague.

¹ Burnet, F. M., and Fenner, F., "The Production of Antibodies" (Melbourne, 1949).

² Lopashov, G. V., and Sereyeva, O. G., *Uspeyehi sovremennoy biol.*, **30**, 234 (1950).

³ Burnet, F. M., Stone, J. D., and Edney, M., *Aust. J. Exp. Biol. Med. Sci.*, **28**, 291 (1950).

⁴ Owen, R. D., *Science*, **102**, 400 (1945).

⁵ Hašek, M., *Ceskoslovenská biologie*, **2**, 29 and 267 (1953).

⁶ Billingham, R. E., Brent, L., and Medawar, P. B., *Nature*, **172**, 603 (1953).

⁷ Hašek, M., *Ceskoslovenská biologie*, **3**, 327 (1954).

⁸ Frenzl, B., Hašek, M., Mašková, V., and Hraba, T., *Ceskoslovenská biologie*, [4, 1 (1955)].

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Crystal Structure of Benzene: a New Type of Systematic Error in Precision X-Ray Crystal Analysis

LAST year, two of us gave a preliminary account¹ of an X-ray analysis of crystalline benzene from which a C—C bond-length of 1.37₈ Å. was derived by differential syntheses with finite series corrections. We have since been able, by means of electronic computer programmes devised by Miss D. Pilling of this Department, to calculate Fourier maps and difference maps in the plane of the molecule, which clearly show that the thermal motion is markedly anisotropic, and detailed quantitative study shows that it is such as to produce a systematic error in the bond-length which is by no means negligible.

We have carried out, on the University of Manchester electronic computer, five cycles of refinement of the anisotropic thermal parameters of the carbon atoms, and find that the mean values of the components of the atomic temperature-factor *B* are:

Perpendicular to the plane of the ring	$4.8 \times 10^{-16} \text{ cm.}^2$
Radially in the plane of the ring	$4.5 \times 10^{-16} \text{ cm.}^2$
Tangentially in the plane of the ring	$7.4 \times 10^{-16} \text{ cm.}^2$

The difference of 2.9×10^{-16} between the last two figures shows, in agreement with nuclear resonance experiments², that an important part of the thermal motion of the benzene molecule at -3°C. consists of rigid-body oscillations about its senary axis. Since the motion of an atom on an arc of a circle must produce a time-averaged electron distribution the maximum of which is displaced towards the centre of the arc, this oscillatory motion must cause the radius of the benzene ring, and therefore the C—C distance, to appear shorter than is actually the case. Displacements in the same sense, although probably smaller in magnitude, arise from oscillations about axes in the plane of the molecule. Detailed analyses of these effects indicate that the correction to the bond-length is at least 0.010 Å. and is probably about 0.015 Å.; the corrected C—C bond-length derived from our work is about 1.39₂ Å., which is now not significantly different from the value 1.397 Å. obtained by Stoeicheff³. Full details of our work will be submitted for publication shortly.

The computations involved in an anisotropic thermal motion analysis are very lengthy, and our work on benzene was only made possible by the availability of the University of Manchester computer. In most cases the corrections may well be too small to justify the computation which would be involved; but it is clear that the possibility of systematic errors in atomic positions due to angular oscillations of the molecules (or of parts of them) arises in nearly all crystal structure analyses.

E. G. COX
D. W. J. CRICKSHANK
J. A. S. SMITH

Department of Inorganic and Structural Chemistry,
University of Leeds.

Feb. 26.

¹ Cox, E. G., and Smith, J. A. S., *Nature*, **173**, 75 (1954).

² Andrew, R. P., and Eades, R. G., *Proc. Roy. Soc., A*, **218**, 537 (1953).

³ Stoeicheff, B. P., *Can. J. Phys.*, **32**, 339 (1954).

The Serpent Spring

IN the course of investigations concerned with the problem of obtaining large elongation or rotational effects by small variations of a force, the following peculiar behaviour of spiral springs has been observed.

A flat spiral spring, as an ordinary clock spring, is fixed at, for example, its inner end. At the outer end a force is applied in a direction perpendicular to the plane of the undeformed spiral. If this force is sufficiently strong, it deforms the spiral spring to a shape which resembles a lifting and uncoiling serpent, as will be seen if Fig. 1 is inverted. Therefore it may be called a 'serpent spring'. Such a spring is very sensitive, under certain conditions, to very small variations of the deforming force either in its magnitude or, in special circumstances, its direction. This sensitivity shows both in variations in length of the spring and in twist.

The sensitivity depends on the inclination of the acting force to the plane of the original spiral. At certain characteristic angles, for a definite magnitude of the acting force, the spring becomes extremely sensitive (critical region). The spring generally shows two different critical shapes. These depend upon the sense of inclination, for example, inclining the clamped end upwards (Fig. 1) or downwards. Fig. 1 has been obtained by photographing a spring in three different states on the same film, corresponding to equal steps in increasing weight. The spring is shown shortly before the critical state; the shapes are reversible, that is, the spring returns to the same

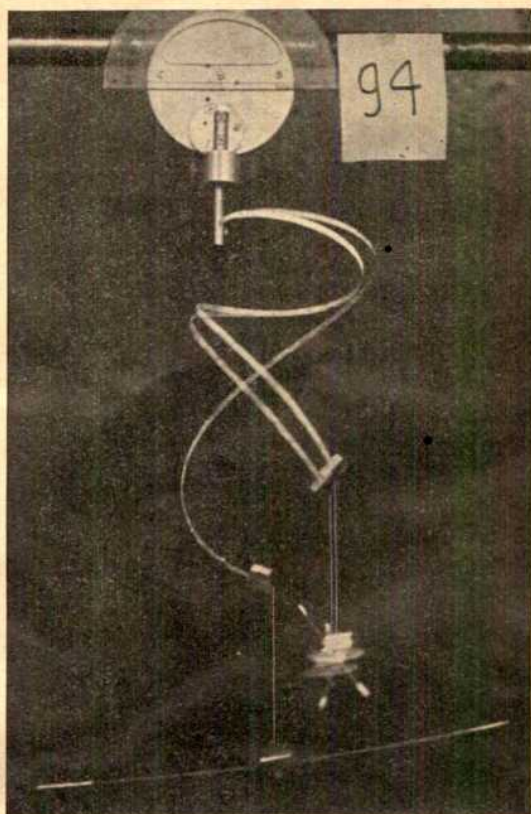


Fig. 1. Critical shapes of a serpent spring
Inclination = $+12.5^\circ$. Spring steel, $a = 2.5 \text{ mm.}$, $b = 0.2 \text{ mm.}$
Original spiral: 1 turns; outer diameter, 100 mm.; inner diameter, 80 mm. Loads: 9.6; 10.1; 10.6 gm.

shape on removing the additional weights. As can be seen, equal steps in loading cause widely different deformations. The step from the second to the third state corresponds to the region of high sensitivity. A pointer was fixed to the scale pan, and from this the twist accompanying the variations in shape can be seen easily.

Using values of inclination which surpass the critical angle, at a certain weight which exceeds W_{cr} , the spring suddenly jumps to a second 'lower' state. If now the loading weight is reduced, length and twist show only small variations, until suddenly, at a load which is less than W_{cr} , the spring jumps back to its former 'upper' state. The more the angle of inclination exceeds its critical value, the greater the area of the hysteresis loop.

To obtain the critical state, it is necessary to use springs which have an oblong cross-section with two unequal axes with a ratio of about 1:10 or preferably more. The longer axis has to be perpendicular to the plane of the undeformed spiral. The spring should have at least one and a half turns in its original state. Springs with more turns show fundamentally the same behaviour, but some peculiarities in detail. The material should be neither too soft nor too stiff, as lasting deformation or breakage may occur. In order to minimize temperature effects, it is advisable to use materials like 'Elinvar' or 'Ni-span-C'.

It is remarkable that there is proportionality between extension and twist over a wide range even when passing the zone of high sensitivity. For springs of about 15 cm. working length, the ratio is of the order of 0.5 mm./degree.

To a large extent the quantitative behaviour is given by

$$W_{cr} = k.E. \frac{ab^3}{d^2}$$

where W_{cr} is the critical weight, k a constant (for springs of the shape used in the experiments mentioned above it is equal to 0.4 for negative inclination), E is the modulus of elasticity, a is width and b is thickness of the spring. The 'sensitive' length d is about πr , in springs of the type of Fig. 1 where r is the mean radius of the winding where the critical deviation occurs.

Without much difficulty the serpent spring is able to show changes in the acting force of one hundred-thousandth by a twist of 0.2° . The variations in length connected with it depend on the absolute dimensions. A serpent spring of this state of sensitivity, having a length of about 10 cm. between clamp and end and showing a ratio of lengthening to twist of 0.4 mm. per degree, extends by 80μ on increasing the force by one hundred-thousandth. This corresponds to the lengthening of a normal helical spring of more than 25 ft. extended length.

The serpent spring may also be used in an inverse form, where the force produced by the spring

is changed by changing the inclination of the system.

I wish to thank Prof. A. O. Rankine, Mr. R. Davies and Dr. D. T. Germain-Jones for their interest, and the chairman of The British Petroleum Co., Ltd., for permission to publish this communication. A detailed paper will be published elsewhere¹.

R. TOMASCHEK

Research Centre,
The British Petroleum Co., Ltd.,
Kirklington Hall,
Near Newark. March 3.

¹ See also Brit. Pat. 711205, 711206.

A Slip-band Exudation Effect observed in Pure Aluminium

EARLIER work on the fatigue behaviour of aluminium — 4 per cent copper alloy had revealed that material was exuded from some of the active slip bands during the later stages of the fatigue test¹. This phenomenon is generally associated with materials which are unstable under the action of fatigue stresses, for example, supersaturated solid solutions. We believe the exudation to be produced by the action of the cyclic stresses on a thin sandwich of material depleted of solute atoms by localized over-ageing.

Annealed pure aluminium does not exude material from the slip striations, but these regions grow in width; and interferometric measurements show that corrugations may form. It is, however, possible in lightly cold-rolled pure aluminium to produce a type of exudation which is similar to that produced in the alloy. This is shown in Fig. 1. This effect is due to very local recrystallization of the disoriented matrix under the action of the cyclic stress, and the subsequent exudation of this softer material. If the material is heavily cold-rolled before fatiguing, the

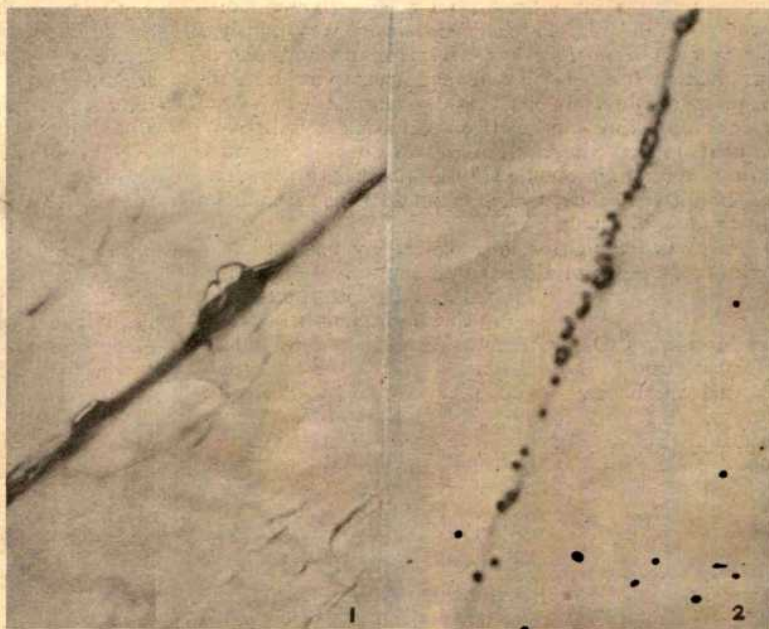


Fig. 1. Exudation produced on lightly cold-rolled pure aluminium fatigued at room temperature. $\times 1,500$

Fig. 2. Pure aluminium fatigued at room temperature and afterwards polished electrolytically. $\times 3,000$

recrystallized zones become too widespread to behave in this manner. Under these conditions, eruptions of larger volumes of material occur at the specimen surface.

From these and other observations made in this laboratory, it appears that exudation is the direct result of cyclic stresses deforming a sandwich of material which is softer than the matrix. Whether this material is a zone depleted of solute atoms as a result of localized ageing or local recrystallization in a pure metal, the final mechanism of failure is the same, namely, the formation of a structural 'soft spot' or stress concentration by the action of cyclic stresses.

Orowan has suggested² that all metals contain soft spots which may deform plastically under the action of cyclic stresses. According to him, these soft regions work-harden, and, depending on the geometry of the soft spot and the stress applied through the elastic matrix, fracture may occur or the plastically deforming region may work-harden until it behaves elastically. Our observations now suggest that although soft spots exist in the crystals before the application of cyclic stress, these are rapidly removed by small slip movements. The soft spots in which fatigue cracks eventually form are not these pre-existing structural inhomogeneities, but ones produced later by the action of the fatigue stresses. As these regions are produced at a later stage in a matrix which was originally more homogeneous, it is unlikely that the process will be reversed and work-hardening again occur before final cracking.

It is suggested that the fatigue process can be divided into two stages. During stage 1, small atomic rearrangements are occurring under the action of the cyclic stress; stage 2 begins when these rearrangements have produced a structural soft spot which, during this stage, is heavily deformed and a crack appears. In pure aluminium these conditions first of all produce a number of discrete holes which later on join up to form the initial crack. These holes are shown in Fig. 2. This specimen was polished electrolytically before and after testing and photographed in the 'as-polished' condition with no subsequent etching. It is probable that these holes are formed by the condensation of large numbers of vacant lattice sites. There is also microscopical evidence for high tensile stresses normal to the plane of the fatigue crack, which would aid this mechanism to produce a crack.

This communication is published by permission of the Chief Scientist, Ministry of Supply.

P. J. E. FORSYTH
C. A. S. STUBBINGTON

Metallurgy Department,
Royal Aircraft Establishment,
Farnborough, Hants. Dec. 29.

¹ Forsyth, *Nature*, 171, 172 (1953).

² Orowan, *Proc. Roy. Soc., A*, 171, 79 (1939).

Vapour Circulating Pumps

In studies of the composition of vapour in equilibrium with liquid mixtures of the atmospheric gases at pressures near 1 atmosphere, a method of procuring a continuous circulation of the vapour was needed. Any pump incorporated in the system was required to operate without changing the volume of the vapour space. It was further specified that

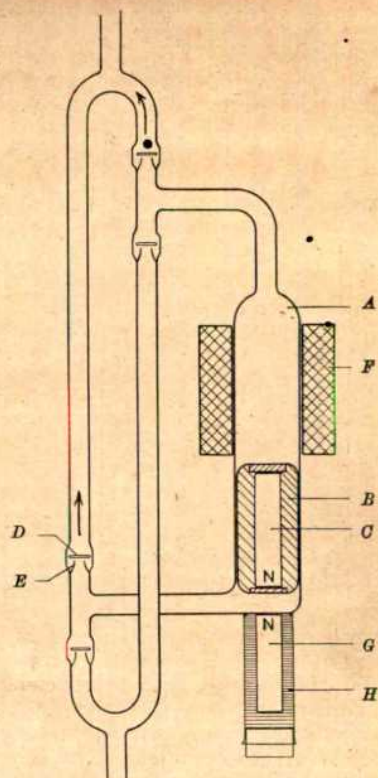


Fig. 1

the materials from which it was constructed should not adsorb large quantities of the vapour.

A pump made in 'Pyrex' glass similar to that described by Ferguson¹, with a horizontal cylinder and solenoid-operated piston, was first constructed. It gave a vapour flow of 5 litres/hr. against a static head of 2.5 cm. water gauge. However, there was very considerable friction between the cylinder and the piston, and after a short while copious quantities of glass powder were formed, which would soon have blocked the whole of the apparatus as well as creating a large area of adsorbing surface. Grinding started somewhat slowly; but once a small quantity of powder had been produced it proceeded very rapidly.

In order to reduce the friction a new pump was made, also of glass, with the cylinder and piston arranged vertically. In due course, however, this pump also produced quantities of glass powder. This grinding action was finally prevented by changing the material of the piston, polythene being used.

The present design of the pump is shown in Fig. 1. It consists of the vertical glass cylinder A and the polythene piston B. Inlet and outlet valves are so arranged that gas flows upward, as indicated by the arrows, on both the rising and falling strokes. Each valve consists of a glass plate D seating on a ground face E. The piston B is 2 in. long and $\frac{7}{8}$ in. diameter and moves in a cylinder 4 in. long, in which it is a fairly close fit. It contains hermetically sealed within itself a permanent magnet C made of Mullard's alloy 'Ticonal E', 1½ in. long and $\frac{3}{8}$ in. square cross-section.

The piston is raised by passing current through the solenoid F and falls freely under its own weight. In the actual pump used, the solenoid was a winding from an old transformer; but a suitable design

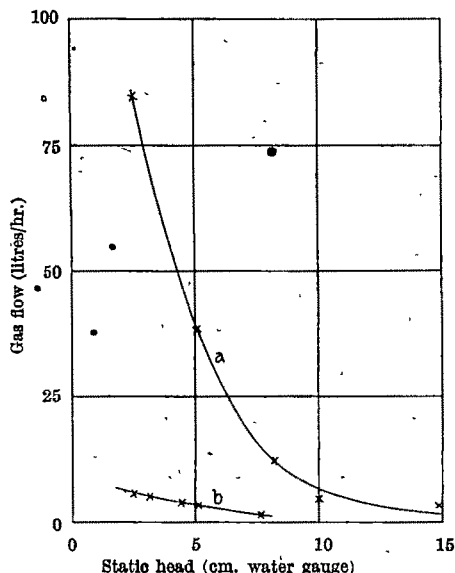


Fig. 2. (a) Vertical pump; (b) horizontal pump

would consist of 1,000 turns of S.W.G. 22 wire with a resistance of about 7 ohms. In this solenoid a current of 1.5 amp. would be sufficient to give satisfactory operation.

In order to prevent the piston breaking through the lower wall of the cylinder, a second magnet *G* is wedged in the lower glass tube *H*, the polarity of the two being so arranged that repulsion occurs as the magnets approach one another.

This pump gives a gas flow considerably greater than that of the first one constructed. Fig. 2 shows the characteristics of both these pumps in terms of the gas flow against various static heads, when operating at 40 strokes/min. The two pumps are of similar dimensions, the swept volumes being 11 c.c. and 15 c.c. respectively for the horizontal and vertical designs. The great difference in the pumping speeds is probably due to the fact that the machined polythene piston is a much closer fit in its cylinder than was the glass piston of the horizontal pump.

This communication is published with the permission of the Directors of the British Oxygen Co., Ltd.

A. H. COCKETT

Research and Development Department,
The British Oxygen Co., Ltd.,
Deer Park Road,
London, S.W.19.
Dec. 29.

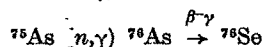
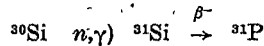
¹ Ferguson, *J. Phys. Chem.*, **31**, 1099 (1927).

Radioactivation Analysis of Arsenic in Silicon

SMALL traces of impurities in the range 0.001–1 p.p.m. of group V elements present in semiconductors such as germanium and silicon have a large effect on the electrical properties. Chemical methods of analysis in this range are very dependent on the purity of the chemical reagents used, and also require large sample weights. On the other hand, the method of radioactivation analysis labels the impurity atoms originally present (provided they produce radioactive isotopes), and these atoms may then be separated

with added carrier and ordinary laboratory grade chemical reagents.

We have applied the radioactivation method to the problem of determining arsenic impurity in silicon in the sub-microgram range. When a sample of silicon containing arsenic impurity is irradiated with thermal neutrons in the pile at Harwell, the following reactions take place:



We have found that the following is a satisfactory method for separating the arsenic impurity. The silicon is first dissolved in sodium hydroxide in the presence of hydrogen peroxide, and arsenious oxide added as carrier; the solution is then acidified with hydrochloric acid and reduced to small bulk under oxidizing conditions.

Once the sample has been taken into solution and made acid, we have followed the method used by Smales and Pate¹ for the separation of arsenic from germanium, namely, reduction to trivalent arsenic by hydrobromic acid, followed by distillation of the trichloride into water. The resulting distillate is then acidified and reduced to elementary arsenic by ammonium hypophosphite, centrifuged off, and slurried on to a counting tray, dried, weighed and the activity measured.

The chemical yield or recovery of arsenic carrier is 80–90 per cent; at a pile factor of 10, an arsenic content of 2–3 p.p.m. gives a count of approximately 9,000 counts/min. from a 0.2-gm. sample on the third day on shelf 2 of a conventional lead castle. The identity of the radioactive isotope is confirmed by plotting the decay curve and also by the energy of the radiation from absorption measurements.

The sensitivity of the method may be estimated as follows: arsenic reaches a saturation activity of 90 mc./gm. at pile factor 1 with one week irradiation

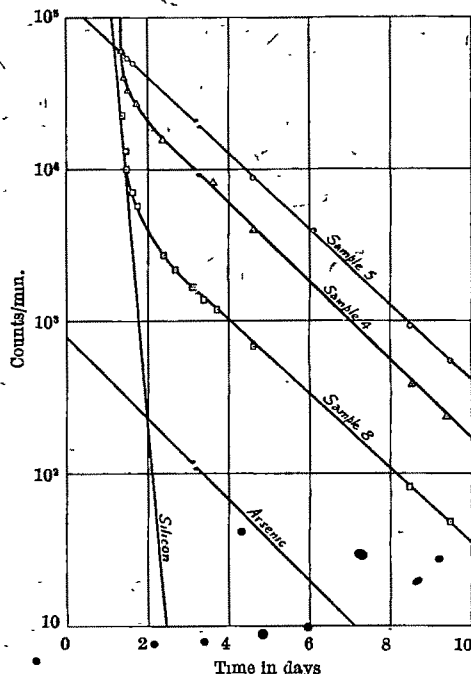


Fig. 1. Decay curves of samples of silicon

(900 mc./gm., maximum pile factor 10). If we take the detection limit of the counting system as 20 counts/min. on the top shelf of a standard lead castle with a geometry of 1/4, then 4×10^{-11} gm. of arsenic would be just detectable. It is convenient, however, to allow the silicon activity to decay before carrying out the chemical separation; thus the detection limit on the third day becomes 3.2×10^{-10} gm., or 0.0003 p.p.m. on a 1-gm. sample.

The accuracy of the method is limited by the uncertainty of the specific activity and shelf factors; but this limitation may be avoided by irradiating known and unknown samples simultaneously and comparing activities.

If arsenic is the major radioactive impurity, then samples may be compared by plotting the radioactive decay curves, provided that the samples are of the same size and shape. The half-life of arsenic-76 (26.8 hr.) is sufficiently different from that of silicon-31 (2.62 hr.) for the curve to be analysed into its components (see Fig. 1). When other radioactive impurities are present in similar amounts, the decay curve becomes more complex, and chemical separation with added carrier is the only certain method of analysis.

As an indication of the results obtainable by this method, samples of specially pure silicon from various sources, including some prepared in this laboratory by the decomposition of silicon iodide, have been examined. The method detected arsenic contents varying according to sample from 0.001 to 3 p.p.m.

J. A. JAMES

D. H. RICHARDS

Research Laboratory,
British Thomson-Houston Co., Ltd.,
Rugby.
Jan. 13.

* Smales, A. A., and Fate, B. D., *Anal. Chem.*, **24**, 717 (1952).

Dye-sensitized Photopolymerization of Styrene

We have found a number of examples of dye-induced photopolymerization of styrene, in which excited dye molecules directly interact with vinyl monomers, thus promoting the polymerization reaction. Further, an interesting example has been recently found in which the initiation of polymerization can be attributed quite certainly to the energy transference in the strict sense of the word.

The systems most extensively investigated were the combinations of styrene and various cyanine dyes. When a mixture of styrene and *n*-butanol (15:1 by volume) containing about 6×10^{-6} mole/l. of pinacyanol iodide, for example, is irradiated by visible light at 60°C. *in vacuo*, decomposition of dye molecules occurs and at the same time polymerization of styrene is greatly accelerated. In Fig. 1 curves *a* and *b* show the amount of polymerization in the light and in the dark plotted against the time-interval of the reaction.

As seen from Fig. 1, the presence of dye does not affect the rate of the thermal polymerization; hence there is no interaction between vinyl monomer and the dye molecule in the ground state. On the other hand, it was ascertained that the dye solution in butanol *in vacuo* is not bleached at all by irradiation, so that the excited dye molecules do not decompose

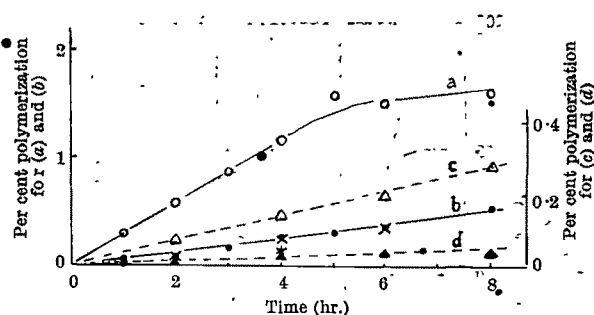


Fig. 1. Polymerization-time relation

Pinacyanol iodide (6×10^{-6} mole/l.)	{	○ —, light	(curve a)	} 60° C.
No dye	{	● —, dark	(curve b)	
Zinc-tetraphenylchlorin (1.1×10^{-5} mole/l.)	{	△ ---, light	(curve c)	} 40° C.
No dye	{	× ---, dark	(curve d)	

The number of photons absorbed is about 1.0×10^{18} /sec. for (a) and about 6.4×10^{17} /sec. for (c). Matsuda V-02 filter for (a) and Matsuda V-R3 for (c)

of themselves. It may be concluded that the excited dye breaks down by the interaction of vinyl monomer accompanied by the production of initiator for the polymerization.

The enhancement of polymerization could be interpreted as solely due to the increase of the rate of the initiation process, and the number of initiators produced by one decomposed dye molecule was found to be about 2. The number, however, is much less than 1 at 40°C., and this would suggest that the bleaching reaction and the initiation reaction are not necessarily the same process. Both the quantum yields for photo-bleaching and photo-initiation of polymerization at 60°C. are of the order of 10^{-4} .

Analogous reactions have been established in other cyanine dyestuffs such as isocyanine, kryptocyanine, heptamethinthiocyanine and pinacyanol chloride, and similar results were obtained, at least qualitatively. In contrast to cyanine dyes, the effects of the addition of other dyestuffs, such as uranine, eosine, trypanflavine and erythrosine, were so small—if any—that quantitative investigations could not be carried out.

An interesting example of photosensitized polymerization which can be interpreted quite certainly as due to the pure transference of energy is the combination of styrene and zinc tetraphenylchlorin. The latter is an easily oxidizable compound containing the nucleus of porphyrin, the photo-oxidation of which was extensively studied by M. Calvin and his school and was interpreted to go via the triplet state¹. It dissolves in styrene quite well. When styrene containing a small quantity of zinc tetraphenylchlorin is illuminated by the light of about 620 mμ *in vacuo* at 40°C., then polymerization takes place to some extent, while thermal polymerization is almost negligible at this temperature (Fig. 1, curves *c* and *d*). The important fact is that the chlorin compound is not decomposed by irradiation in this case.

In view of the facts that the substances contained in the system are only styrene and zinc tetraphenylchlorin, and that the existence of the triplet state of the latter has been established by Calvin, there seems to be no doubt that the initiation of polymerization is induced by the energy transferred from the triplet state of the chlorin compound to the styrene molecule.

We thank Prof. M. Calvin, who suggested testing zinc tetraphenylchlorin and gave us part of the

sample, and also Dr. T. Ogata, who supplied various cyanine dyestuffs.

M. KOIZUMI
A. WATANABE
Z. KURODA

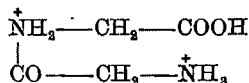
Polytechnic Institute,
Osaka City University,
Osaka.
Nov. 17.

¹ Calvin and Dorough, *J. Amer. Chem. Soc.*, **70**, 699 (1948); **71**, 4024 (1949).
² Huennekens and Calvin, *J. Amer. Chem. Soc.*, **71**, 4081 (1949).

Mechanism of the Acid Hydrolysis of Glycylglycine

NUMEROUS studies have been made on the hydrolysis of polypeptides for the determination of the composition of proteins. Usually these hydrolyses are conducted in acid solution. The kinetics of the acid hydrolysis of some dipeptides has been studied by Synge¹ and Lawrence and Moore²; but no mechanism has been suggested. However, in the acid hydrolysis of the amides, Benrath³ and Euler and Ölander⁴ have reached the conclusion that it is the amide cation which hydrolyses. Ingold⁵ states that the rate-controlling step is a bimolecular reaction between a water molecule and the amide cation.

Synge¹ used equal volumes of glacial acetic acid and 10 *N* hydrochloric acid, and found the hydrolysis was first-order with respect to the dipeptide. Lawrence and Moore² used excess acid in water and found the hydrolysis was second-order, that is, first-order both with respect to the dipeptide and hydrogen ion concentrations. The results of both investigations are consistent with the explanation that it is the dipeptide cation



which hydrolyses; but the concentration of water used was large and it was not possible to ascertain its influence on the reaction-rate.

I have examined the hydrolysis of glycylglycine in aqueous acetic acid at low concentrations of water with excess perchloric acid and have obtained information on the effect of water, thus allowing a mechanism to be assigned to the hydrolysis. The hydrolysis was studied by the sealed-tube technique and its extent determined by titrating the excess perchloric acid with sodium acetate in glacial acetic acid, with methyl violet as the indicator.

Glacial acetic acid was chosen as the solvent, because in this, amines and peptides are strong bases and perchloric acid is a strong, completely ionized acid. It was also possible to vary the concentration of water. Therefore with excess perchloric acid, glycylglycine will be present as glycylglycine hydroperchlorate. Under these conditions the rate of hydrolysis at low concentrations of water was found to be given by:

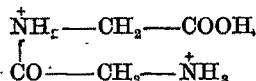
$$\text{Rate} = k_2 [\text{glycylglycine HClO}_4] [\text{H}^+]$$

The results given in Table 1 show that, over a tenfold change in the water concentration, there is a very slight variation in the velocity constant and the rate is practically independent of the water concentration.

Table 1. SECOND-ORDER CONSTANT FOR THE HYDROLYSIS OF GLYCYLGLYCINE IN AQUEOUS ACETIC ACID WITH PERCHLORIC ACID.

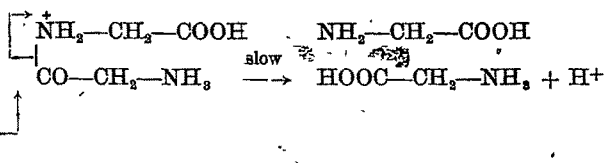
Water (per cent by vol.)	$k_2 \times 10^4 \text{ sec.}^{-1} \text{ gm. mol.}^{-1} \text{ l.}$ 100° C.	120° C.
0.5	1.33	5.46
1.0	1.55	6.06
2.0	1.60	6.36
5.0	1.26	5.42

Since the peptide nitrogen is much less basic than the terminal amino group, then the dispositive ion



will be present in small concentrations which will be proportional to [glycylglycine HClO₄] [H⁺].

The determinations by Noyce and Castelfranco⁶, and Smith and Elliot⁷, of the acidity function of strong acids in acetic acid, show that the hydrogen ion activity at low concentrations of water decreases with increasing water content. A reaction in acetic acid catalysed by hydrogen ions should therefore be retarded on the addition of the water; but since such an addition causes no change in the rate, it is to be concluded that the water has an accelerating effect which approximately compensates the retardation. This accelerating effect can be explained if the mechanism is a bimolecular reaction between a water molecule and the dipeptide ion as follows:



These results will be described in more detail elsewhere.

R. J. L. MARTIN

Division of Industrial Chemistry,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.

¹ Synge, R. L., *Biochem. J.*, **39**, 351 (1945).

² Lawrence, L., and Moore, W. J., *J. Amer. Chem. Soc.*, **73**, 3978 (1951).

³ Benrath, A., *Z. anorg. allg. Chem.*, **151**, 53 (1926).

⁴ Euler, H. v., and Ölander, A., *Z. phys. Chem.*, **131**, 107 (1928).

⁵ Ingold, C. K., "Structure and Mechanism in Organic Chemistry" (Cornell University Press, New York).

⁶ Noyce, D. S., and Castelfranco, P., *J. Amer. Chem. Soc.*, **73**, 4482 (1951).

⁷ Smith, T. L., and Elliot, J. H., *J. Amer. Chem. Soc.*, **75**, 3586 (1953).

Reactions between Quinones and Proteins

THE phenolase complex, by which I mean that pair of enzymic activities occurring together and associated with copper-protein, which catalyses the *o*-hydroxylation of phenols and dehydrogenation of *o*-diphenols, is found in organisms throughout the phylogenetic scale, and catalyses the formation of quinones from *o*-diphenols. These enzyme-generated *o*-quinones react with proteins to form, *inter alia*, the sclerotized cuticles of arthropods, and other phyla¹, the sepia of squid, and the melanins which colour the teguments, feathers, hair and eyes of the vertebrates². In this communication I wish briefly to describe some hitherto undescribed phenomena which appear to play important parts during the interaction of protein-diphenol-phenolase systems.

Peptide effect. Amines react readily with *o*-diphenol-phenolase systems in the following way³:

- A. Catechol + [O] $\xrightarrow{\text{(phenolase)}}$ *o*-quinone + H₂O.
 B. *o*-Quinone + amine $\rightarrow$ amino-hydroquinone
 C. Amino-hydroquinone + *o*-quinone $\rightarrow$ amino-quinone + catechol

The formation of *o*-quinone from catechol in the presence of phenolase (reaction A) is very rapid and consumes one atom of oxygen per molecule of catechol oxidized. In the presence of amino or sulphhydryl groups, coupling reactions of type B take place. The oxidation-reduction potentials of the products are such that these coupling reactions are followed by the reductive re-formation of catechol (reaction C). The enzymic re-oxidation of the re-formed catechol then leads to an overall consumption of a second atom of oxygen per molecule. Under adequate conditions, the rate of the coupling reaction can be measured by the initial rate of consumption of the second atom of oxygen, and by the development of the absorption spectra of the amino-quinones. Using these techniques, we find that the rate of the coupling reaction (B) is markedly influenced by the nature of the substituents on the nitrogen atom, increasing, for example, in the order butyl amine, glycine, glycylglycine and glycylglycylglycine, and in the order: diethylamine, proline and N-terminal proline (as in the protamine, salmine). The peptide bond thus has a characteristic effect upon the rate of reaction between enzyme-generated *o*-quinones and amines; the magnitude of this effect appears to bear some relationship to $pK_a(\text{NH}_3^+)$ or $pK_a(\text{NH}_2^+)$ in any series, but since the coupling rate of proline ($pK_a = 10.6$) is comparable to that of glycylglycylglycine ($pK_a = 7.9$)⁴, the factors which control the rates of reaction of quinones with zwitterionic amino-acids and peptides are not identical with the factors which determine the pK_a values of the amines.

Substrate binding and coupled oxidations of protein derivatives. We also find that the reactions of enzyme-generated *o*-quinones with peptides or proteins produce N- and S-catechol derivatives which cannot act as substrates for diphenolases. In the presence of excess free *o*-quinone, however, catecholic proteins are oxidized to the corresponding quinonoid proteins. The following instances are illustrations. In a system containing catechol and crystalline bovine serum albumin in molecular ratios between 1/1 and 3/1, a total of one atom of oxygen is consumed per molecule of catechol enzymically oxidized, the product remaining colourless. In systems containing more than three molecules of catechol per molecule of albumin, relative oxygen consumption is sharply increased and the products have absorption spectra with a maximum at 480 μ , corresponding to the spectra of 4-amino-*o*-quinone derivatives. Similarly, in systems containing catechol and glutathione in molecular ratios up to 0.8, the total oxygen consumed as a result of enzymic oxidation remains at one atom per molecule of catechol. When the molecular ratio is increased to 0.9 and above, total oxygen consumption increases very sharply to 2.8 atoms per molecule of catechol. This sharp break is accompanied by a marked difference in the colours of the final products, namely, from colourless (max. 255 and 285 μ) to deep purple (max. 270, 320, 390 and 540 μ).

Thus, the reactions occurring during the interaction of catechol-diphenolase-protein systems ap-

pear to be dependent upon the heightened reactivity of N-terminal amino-groups towards quinones, and upon the molecular ratio of the diphenol (that is, *o*-quinone) to peptide or protein. When these ratios are low, catecholyl proteins form and persist even in the presence of excess phenolase; but when the ratio is high, coupled oxidations of catecholyl proteins to quinonoid proteins readily take place. The formation of sclerotized insect cuticles, sepia and vertebrate melanoproteins may therefore proceed through N-terminal aminocatechols, N-terminal aminoquinones or the corresponding S-compounds; and end-to-end linkage of protein molecules, followed by the development of cross-linkages through the more slowly reacting ϵ -lysyl amino-groups and the adsorption of quinones and quinonoid polymers by secondary linkages⁵.

This work was made possible in part by a grant from the National Science Foundation, the support of which is gratefully acknowledged.

H. S. MASON

Department of Biochemistry,
 University of Oregon Medical School,
 Portland, Oregon.
 Dec. 29.

¹ Richards, A. Glenn, "The Integument of Arthropods" (Univ. Minnesota Press, 1951)

² Fox, D. L., "Animal Biochromes and Structural Colours" (Camb. Univ. Press, 1951).

³ Jackson, H., and Kendall, L. P., *Biochem. J.*, **44**, 477 (1949). Hackman, R. H., and Todd, A. E., *Biochem. J.*, **55**, 631 (1953).

⁴ Cohn, E. J., and Edsall, J. T., "Proteins, Amino Acids and Peptides" (Reinhold, 1943).

⁵ Mason, H. S., "Advances in Enzymology", **13** (1955).

Chromatography of Phospholipids

THERE is a need for improved procedures for the analysis of phospholipids, and the brief account given here describes a technique which possesses considerable advantages.

In a typical experiment a rat was injected intravenously with 0.8 mc. of phosphorus-32 (as NaH³²PO₄) one hour before being killed. The fat was extracted from the liver and washed with 0.1 N hydrochloric acid to remove cations and contaminating phosphorus-32. The fat (100–300 mgm.) was treated in benzene with fluoro-2:4-dinitro-benzene in the presence of triethylamine. There is a complete reaction with all the available amino groups within two hours at 40°. The excess fluoro-dinitro-benzene and any by-products can be removed by chromatography or by distillation on to a cold finger at a pressure of less than 0.05 mm. of mercury. The dinitrophenyl-lipid, which was washed with 0.1 N hydrochloric acid to remove the last traces of triethylamine, was then treated with diazomethane. Secondary phosphates are quantitatively converted to tertiary esters under these conditions¹, as also is the carboxy group in phosphatidyl serine.

The fat (97 mgm.) was chromatographed on 'Hyflo-super-cel' (0.5 gm. of absorbent per mgm. of fat), yielding four main fractions which could be distinguished by their absorption spectra: (1) light petroleum eluted the glycerides and vitamin A; the phosphorus content was low, but some phosphorus was always present in this fraction. (2) Benzene or benzene-chloroform mixtures eluted a fraction with λ_{max} at 328 m μ (light petroleum) containing nearly equimolar proportions of dinitrophenyl groups and

phosphorus. On further chromatography this fraction separated into a fast-running fraction which contained mostly ethanolamine, while serine predominated in the slow-running fractions. (3) Chloroform containing 10 per cent ethanol eluted material with $\lambda_{\max}$ at 345 m μ (light petroleum). The molar ratio of dinitrophenyl groups to phosphorus was low (less than 0.5) and further chromatography showed that this material was a mixture. Fractions were obtained with 8-100 per cent amino-phospholipid. The specific radioactivity varied considerably and bore no simple relation to the dinitrophenol absorption, indicating that both the cephalins and lecithins present varied in specific radioactivity. (4) Ethanol slowly eluted material with little or no absorption due to the dinitrophenyl groups, and this fraction, which was not always recovered quantitatively, contained predominantly choline-phospholipids.

The specific radioactivity tended to be highest in the fraction with $\lambda_{\max}$ at 328 m μ ; but some fractions with $\lambda_{\max}$ at 345 m μ were nearly as high. The final fractions had the lowest specific radioactivity, which was about a quarter of the highest value obtained.

Dinitrophenyl-octadecylamine has $\lambda_{\max}$ (light petroleum) at 330 m μ , but in ethanol it is 347 m μ . The dinitrophenyl-lipids (not treated with diazomethane) all absorb at 345 m μ . It is unexpected that some of the dinitrophenyl-lipids, after treatment with diazomethane, should still absorb at 345 m μ . The explanation of this is as yet unknown. The proportion of dinitrophenyl-lipid with $\lambda_{\max}$ at 328 m μ and at 345 m μ varies; in liver lipid there is more material absorbing at 345 m μ than at 328 m μ , whereas in brain lipid the opposite is the case.

In conclusion, it may be said that an examination of the results of several recent investigations², together with the present results, shows that phospholipids cannot be a simple mixture of phosphatidyl choline, phosphatidyl serine and phosphatidyl ethanolamine, together with small amounts of sphingomyelin and inositol phospholipids. It now seems likely that additional molecular species are present.

F. D. COLLINS
L. W. WHEELDON

Department of Biochemistry,
John Curtin School of Medical Research,
Australian National University,
Canberra, A.C.T.

¹ Atherton, F. R., Howard, H. T., and Todd, A. R., *J. Chem. Soc.*, 1108 (1948).

² Lea, C. H., and Rhodes, D. N., *Biochem. J.*, **54**, 467 (1953). Cole, P. G., Lather, G. H., and Ruthven, C. R. J., *Biochem. J.*, **54**, 449 (1953). Lovern, J. A., *Biochem. J.*, **54**, 126 (1953). Lovern, J. A., and Olley, J., *Biochem. J.*, **54**, 128 (1953). Olley, J., and Lovern, J. A., *Biochem. J.*, **54**, 559 (1953).

Muscle Sodium

It was recently considered¹ that the sodium content of the frog sartorius muscle may be constituted as follows:

	m. equiv./kgm.
Total mean sodium	24
Interspace	13-14
A special region sodium	6-8
General fibre sodium	2-5

It could be inferred from the evidence that the special region referred to above was either a special group of fibres into which sodium entered much more rapidly than into the fibres in general, or it was the sarcolemma of each fibre. Strong evidence has now

been obtained by extensive potential measurements in the single fibre of the sartorius, using the micro-electrode technique, that the region in question is not a group of fibres, and it may therefore be inferred that it is the sarcolemmas of the fibres in general².

It may be assumed that 2-5 m. equiv. sodium/kgm. of sodium exist within the fibres in general. The following evidence therefore leads to the conclusion that the greater fraction of this moiety is not free, but is in some way firmly held and prevented from mixing with sodium-24 during twenty-four hours.

(a) It was noticed that when frogs were injected with sodium-24, the sartorii removed the following day and then immersed in isotonic glucose solution containing 5 m.mol. potassium sulphate/litre, 99 per cent of the labelled sodium emerged from the muscle in 90 min. But 10 per cent of the total muscle sodium, as measured by the flame photometer or by a uranyl acetate method, remained up to two hours or more. This was confirmed in a series of experiments using the purest chemical substances and with suitable blank experiments.

Fig. 1 shows the average values obtained where the original values for the labelled sodium and for the total sodium are both regarded as 100. There is no such difference between the exit of labelled and total sodium apparent with liver.

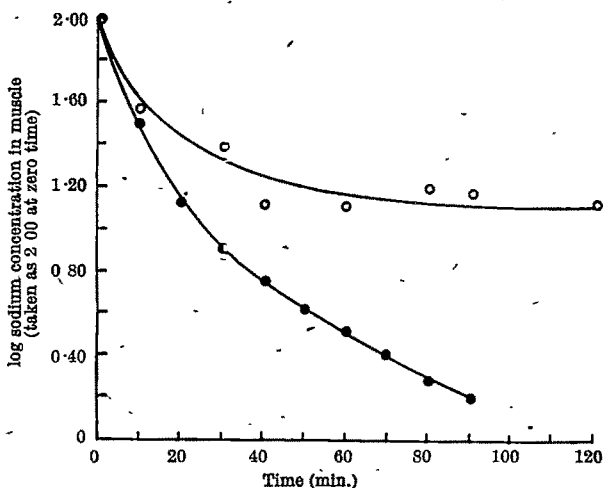


Fig. 1. Curves showing exit of total sodium (circles) and labelled sodium (dots) from sartorii into isotonic glucose containing 5 m.mol. potassium sulphate/litre

(b) After this, a series of observations on the ratio of labelled sodium to total sodium in the muscle and in the plasma was made. From the results obtained, there were 19.7 ± 1.0 m. equiv. labelled sodium and 24.5 ± 0.9 m. equiv. total sodium per kgm. muscle, showing a difference of 4.8 ± 1.3 .

The difference would seem to indicate an even greater amount of unlabelled sodium than the immersion experiments; but the statistical variation is relatively wide and such divergence is not significant.

E. J. CONWAY
MARY J. CAREY

Dept. of Biochemistry and Pharmacology,
University College,
Dublin.
Feb. 25.

¹ Carey, M. J., and Conway, E. J., *J. Physiol.*, **125**, 232 (1954).

² Conway, E. J., and Keenan, R. (unpublished experiments).

Total and 'Exchangeable' Potassium in Humans

THE presence of the naturally radioactive isotope potassium-40 to the extent of 0.012 per cent in potassium affords a convenient means of measuring the potassium content of humans, provided that no other radioactive elements (for example, radium) are present in the body. Of the total amount of potassium present, only some is said to be 'exchangeable', as measured by the method of isotopic dilution using the short-lived isotope potassium-42.

The total potassium content of the human body expressed as a percentage of the body-weight has been quoted as 0.21, per cent¹ and 0.35 per cent² by methods based on chemical analysis of human remains, while the results of Burch and Spiers³ based on total-body radioactivity measurements indicate 0.21 ± 0.01 per cent (ten males and three females, aged 19–20 years), 0.21 ± 0.01 per cent (eleven males aged 26–41 years) and 0.21 ± 0.02 per cent (four males, aged 60–79 years). The amount of 'exchangeable' potassium is reported as 0.18 ± 0.01 , per cent of body-weight for thirty males by Corsa *et al.*⁴, who conclude that the exchangeable fraction is probably 5 per cent less than the total potassium. The mean 'exchangeable' potassium content of twenty females is given as 0.12 ± 0.01 , per cent of body-weight by Aikawa *et al.*⁵. These results are generally confirmed by those of Blainey *et al.*⁶, who quote 0.17 ± 0.01 , per cent for seventeen males and 0.13 ± 0.01 , per cent for seven females, while Edelman *et al.*⁷ give the value of 0.16 per cent for fourteen females.

We have measured both total and 'exchangeable' potassium on a number of subjects; the total content was determined by measurements of body radioactivity using a total-body γ -monitor, ascribing the whole of the response to the radioactivity of potassium-40 (unpublished work by J. R.), and comparison with the radioactivity of weighed amounts of pure potassium chloride. 'Exchangeable' potassium was measured by the isotopic dilution technique, using about 50 μ c. of potassium-42 injected intravenously, and the determinations were carried out 24–36 hr. after injection. We have not detected any differences attributable to this time interval. Radioactivity measurements were made with a γ -scintillation counter, and potassium analyses were made with a flame photometer. All the persons were healthy young Danish subjects, with no history of work with long-lived radioactive isotopes, and with no lengthy period of residence outside Denmark. The results for six males and four females are shown in Table 1.

Table 1

Subject No.	Sex	Age	Weight (kgm.)	'Exchangeable' potassium		Total potassium	
				gm.	% of body-weight	gm.	% of body-weight
1	M	29	75	138	0.19	148 $\pm$ 18	0.20 $\pm$ 0.03
2	M	30	86	160	0.19	146 $\pm$ 18	0.17 $\pm$ 0.03
3	M	24	68	145	0.21	163 $\pm$ 18	0.24 $\pm$ 0.03
4	M	22	72	106	0.15	141 $\pm$ 18	0.20 $\pm$ 0.03
5	M	31	74	138	0.19	174 $\pm$ 18	0.24 $\pm$ 0.03
6	M	23	82	174	0.21	199 $\pm$ 18	0.24 $\pm$ 0.03
7	F	28	59	102	0.17	111 $\pm$ 22	0.19 $\pm$ 0.03
8	F	18	61	116	0.19	130 $\pm$ 18	0.21 $\pm$ 0.03
9	F	22	56	98	0.16	113 $\pm$ 18	0.20 $\pm$ 0.03
10	F	17	67	101	0.15	127 $\pm$ 18	0.19 $\pm$ 0.03

Mean for 6 males: 0.19 ± 0.02 , 0.21 ± 0.01 ,
Mean for 4 females: 0.16 ± 0.01 , 0.19 ± 0.01 ,

The errors quoted for the total potassium contents are the probable errors associated with the statistics of the measurements; it is difficult to assess the error in individual determinations of the 'exchangeable' potassium, but repeat measurements on a few subjects suggest that it is rather less than 10 per cent. With one exception, where the difference is not significant, the 'exchangeable' potassium content is less than the total by 7–25 per cent (mean 15.2 per cent). The wide range of this difference is to be expected in view of the probable errors quoted in Table 1, and any biological variations are therefore swamped by the instrumental errors. Our results are thus in harmony with the measurements of other workers in this field, except that the difference of 5 per cent estimated by Corsa *et al.*⁴ appears to be too low.

We have also measured the total and 'exchangeable' potassium contents of a patient suffering from a non-characteristic type of hereditary periodic paralysis. The results were 158 ± 20 gm. (0.24 ± 0.03 per cent of body-weight) for total potassium and only 85 gm. (0.13 per cent of body-weight) for 'exchangeable' potassium. This discrepancy has not yet been confirmed in other members of the patient's family.

The measurements of total-body radioactivity were made while one of us (J. R.) was on leave of absence from the Atomic Energy Research Establishment, Harwell.

J. RUNDO
U. SAGILD

Finsen Laboratory,
Copenhagen Ø.
Jan. 24.

¹ Shohl, A. T., "Mineral Metabolism" (Amer. Chem. Soc. Mon. Ser., Reinhold Pub. Corp., New York, 1939).

² Hawk, P. B., Oser, B. L., and Summerson, W. H., "Practical Physiological Chemistry" (12th edit., Churchill, London, 1947).

³ Burch, P. R. J., and Spiers, F. W., *Science*, 129, 719 (1954).

⁴ Corsa, L., Olney, J. M., Steenburg, R. W., Ball, M. R., and Moore, F. D., *J. Clin. Invest.*, 29, 1280 (1950).

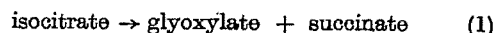
⁵ Aikawa, J. K., Harrell, G. T., and Eisenberg, B., *J. Clin. Invest.*, 31, 367 (1952).

⁶ Blainey, J. D., Cooke, W. T., Quinton, A., and Scott, K. W., *Clin. Sci.*, 13, 165 (1954).

⁷ Edelman, I. S., *et al.*, *Science*, 115, 447 (1952).

Distribution and Formation of Isocitritase

A NEW reaction of tricarboxylic acids, and the possibility of an alternate oxidative pathway, was indicated by the demonstration by Campbell, Smith and Eagles¹ of glyoxylate formation from citrate by extracts of *Pseudomonas aeruginosa*. By a preliminary fractionation of the pseudomonad extract, particularly by the removal of aconitase, Smith and Gunsalus² demonstrated the stoichiometry of the reaction as:



and showed that this enzyme system, which we termed 'isocitritase', required magnesium ion and a mercapto compound as activators. Also following the lead of Campbell, Smith and Eagles, Saz³, although he did not separate the aconitase from the pseudomonad extracts, has concluded from reaction-rates that isocitrate is the substrate, and from inhibitor data and stimulation by yeast kochsaft that both organic and inorganic activators are required. Olson⁴ has also recently reported glyoxylate formation from tricarboxylic acids by *Penicillium chrysogenum* and other fungi, including baker's yeast, by what appears to be an isocitritase mechanism.

Table 1. ISOCITRITASE DISTRIBUTION (AEROBIC CELLS)

Organism* and strain	Isocitritase (units/mgm. protein)
1. <i>P. aeruginosa</i> , 9027	1.55
2. <i>P. fluorescens</i> , A3.12	1.32
3. <i>P. fluorescens</i> , B.8bs	0.76
4. <i>P. putrefaciens</i> , 207	1.77
5. <i>Azotobacter agilis</i> , 4.4	1.68
6. <i>Azotobacter vinelandii</i> , 0	1.35
7. <i>Acetobacter aceti</i> , F.4	0.86
8. <i>Escherichia coli</i> , Crooks	0.93
9. <i>Serratia marcescens</i> , 3M4	0.65
10. <i>Micrococcus lysodeikticus</i> , 4698†	2.10

* Cells 1-9 were grown with aeration in an acetate 0.5 per cent, glutamate 0.2 per cent, ammonium salts medium. Cell paste (at 200 mgm. per ml. of M/50 phosphate buffer, pH 7.0) was oscillated 15 min. in a 10 kc./s. Raytheon oscillator and centrifuged 1 hr. at 18,000 g to obtain a cell extract.

† 1 unit = 1 μ mole glyoxylate produced per 10 min. Reaction mixture contained: 20 μ moles DL-isocitrate; 3 μ moles magnesium chloride, 10 μ moles glutathione, 200 μ moles tris-(hydroxymethyl)-aminomethane buffer pH 7.6, extract 3-5 mgm. protein.

‡ Grown on a DL-malate 0.5 per cent, NZ amine 0.2 per cent, salts medium, cell extract obtained by lysis with lysozyme.

In extending earlier studies of diverse metabolic pathways in micro-organisms, the isocitritase content of several bacterial extracts under study in our laboratory was measured. The results for organisms grown aerobically on organic acids as energy source are shown in Table 1. The aerobic Gram-negative rods of the *Pseudomonas* and *Azotobacter* genera were all high in isocitritase activity, as was the related acid-tolerant Gram-negative aerobe *Acetobacter aceti*—which also possesses a complete oxidation system⁵. The two facultative Enterobacteriaceae possessed lower, but comparable, levels of isocitritase. The aerobic Gram-positive coccus *Micrococcus lysodeikticus* possessed the highest activity of any strain reported; whether the altered growth conditions, malate plus organic nitrogen source, were contributing factors has not so far been determined. The isocitritase-level in *M. lysodeikticus* would imply a suitable source of enzyme for fractionation.

The very marked alteration in enzymatic content demonstrated, in facultative and aerobic organisms, in response to growth conditions prompted us to assay extracts of representative strains from several growth conditions. *E. coli*, Crooks strain, was harvested from three media: the acetate-salts medium used for isocitritase production², the glucose glutamate salts medium used for keto-acid oxidase production⁴, and the glucose tryptone yeast extract medium used for anaerobic growth to induce citritase formation⁶. As shown in Table 2, only the *E. coli* cells grown aerobically with organic acid as source of energy contained isocitritase. With glucose, as source of both aerobic energy and of anaerobic (fermentative) energy in the presence of citrate to induce citritase formation⁶, the cells formed were devoid of isocitritase (Table 2). Thus in *E. coli*,

citritase and isocitritase appear to operate anaerobically and aerobically respectively. It is also noteworthy that the isocitritase content of *P. aeruginosa* devoid of fermentative pathway to sustain growth is reduced about 50 per cent by growth on glucose instead of acetate.

In addition, extracts of two *Acetobacter* strains, *suboxydans* and *aceti*, grown on glycerol as source of energy and of carbon in the presence of organic nitrogen⁵, were devoid of isocitritase. *Acetobacter suboxydans* does not possess a complete oxidative cycle, lacks condensing enzyme, and isocitric and α -ketoglutaric acid dehydrogenase⁵, and requires vitamins and at least traces of glucose or glycerol for growth⁵. This strain does, however, possess aconitase, which may imply an alternative pathway of citrate formation and/or utilization under altered growth conditions—thus the assumption should not as yet be drawn that *A. suboxydans* is devoid of an isocitritase-forming mechanism. The *Acetobacter aceti* strain, when grown on an acetate-salts medium, contains isocitritase (Table 1) and, like *E. coli*, does not form isocitritase when grown on carbohydrate (glycerol) medium.

While further studies will be required to clarify these diverse metabolic patterns, including the source of the biosynthetic precursors, it is tempting to suggest that the C_2 precursor of glycine and of C_1 may arise from both the tricarboxylic acid cleavage, presumably via isocitritase, and from glucose, possibly from 'glycolaldehyde-DPT' via transketolase reaction—the source in a given case depending on growth conditions and enzymatic patterns.

These observations also lend further credence to Krebs's suggestion of the tricarboxylic acid cycle as a precursor of biosynthetic intermediates, even though by alternative reactions of cycle intermediates^{2,6}, and further to emphasize that diverse pathways in the oxidative, as well as in aerobic and anaerobic carbohydrate metabolism, remain to be enumerated and clarified.

ROBERTS A. SMITH
I. C. GUNSALUS

Department of Bacteriology,
University of Illinois,
Urbana, Illinois.
Dec. 1.

¹ Campbell, J. J. R., Smith, R. A., and Eagles, B. A., *Biochim. et Biophys. Acta*, 11, 564 (1953).

² Smith, R. A., and Gunsalus, I. C., *J. Amer. Chem. Soc.*, 76, 5002 (1954).

³ Saz, H. J., *Biochem. J.*, 58, xx (1954).

⁴ Olson, J. A., *Nature*, 173, 695 (1954).

⁵ Rao, M. R. R., and Gunsalus, I. C., *J. Bact.* (in the press).

⁶ Grunberg-Manago, M., and Gunsalus, I. C., *Bact. Proc.*, 73 (1953).
Gunsalus, I. C., in McElroy, W. D., and Glass, B., "Mechanism of Enzyme Action", 573 (Johns Hopkins Press, 1954).

Table 2. ISOCITRITASE FORMATION; EFFECT OF GROWTH CONDITIONS

Aerobiosis and growth substrate	Isocitritase (units/mgm. protein)		
	<i>P. aeruginosa</i> , 9027	<i>A. aceti</i> , F.4	<i>E. coli</i> , Crooks
Aerobic			
Acetate	1.55	0.86	0.93
Glucose*	0.80	—	nil
Glycerol†	—	nil	—
Anaerobic			
Glucose‡	No growth	No growth	nil

* Medium, same as for acetate (Table 1), except 0.3 per cent glucose substituted for acetate.

† Glycerol 2 per cent, NZ amino 1 per cent, yeast extract 1 per cent.

‡ Glucose 1 per cent, glutamate 0.2 per cent, yeast extract 0.5 per cent ammonium salts.

Concentration of Iodine-131 across the Placenta of the Guinea Pig and the Rabbit

DURING the course of an investigation on the structure and function of the guinea pig fetal thyroid, it was noted that a concentration gradient of iodine-131 is established across the placenta after a single injection of iodine-131 is given to the mother. 3 mgm. of propylthiouracil per 100 gm. body-weight was injected subcutaneously in the pregnant animals, thus preventing organic binding of iodine. Forty to forty-five minutes later the dose was repeated

and 100 μ c. of carrier-free sodium iodide-131 in 2 ml. of distilled water was injected subcutaneously in the right axilla. One hour later the animal was anaesthetized with 'Nembutal' and ether, a midline abdominal incision was made, the uterus opened and the foetuses exposed and individually bled from the umbilical cord or from the heart. Maternal blood was collected by heart puncture before and after the removal of the foetuses. Both maternal and foetal blood was collected in heparinized centrifuge tubes. Either 0.5- or 1-ml. samples of plasma were diluted with distilled water to a volume of 10 ml. in 12-ml. glass containers and the radioactivity counted in a Geiger-Müller multiple counter¹.

Of the ten guinea pigs studied so far, all of which were between forty and sixty days pregnant, the iodine-131 concentration in the foetal plasma was 1.5-5 times higher than the iodine-131 concentration in the maternal blood. Because the concentration of iodine-131 in the maternal blood, as indicated by heart puncture samples before and after removal of foetuses (a 15-min. interval), was on a rising, steady or early falling curve, the ratio found of iodine-131 in foetal plasma to that in maternal plasma reflects a true high plasma concentration of inorganic iodide in the foetal blood.

The iodine-131 in the foetal blood was not precipitable by protein precipitants, and when the foetal plasma was allowed to come to equilibrium with its maternal plasma across a semi-permeable collodion membrane, the iodine-131 concentration was found to be equal in both. The results, together with the further findings that the ratio of iodine-131 in foetal plasma to that in maternal plasma was reversed in two guinea pigs given 100 mgm. of sodium thiocyanate, indicate that there is a transport mechanism for iodide in the guinea pig placenta comparable to that in the thyroid gland, salivary glands and gastric mucosa.

It was possible to demonstrate the same high ratio of iodine-131 in foetal plasma to that in maternal plasma in three pregnant rabbits, all of which had a steady level of iodine-131 in the plasma at the time of removal of the foetuses; but the existence of a similar ratio could not be demonstrated in rats.

One of us (J. L.) is in receipt of a grant from the Medical Research Council, and the other (R. F. S.) acknowledges a fellowship of the National Research Council, Canada.

J. LOGOTHETOPOULOS
R. F. SCOTT

Department of Pathology,
Postgraduate Medical School of London,
London, W.12.
March 3.

¹ Veall, N., and Baptista, A. M., *Brit. J. Radiol.*, 27, 198 (1954).

Urinary Excretion of a Substance after a Single Dose

THE method of Stern¹ for representing experimental data seems to be useful. However, the equation of Haigh and Reiss² has good theoretical justification, and it seemed worth while to see whether there was any simple relation between the two formulæ. Stern derives the equation

$$x \log 2 = Q \log \frac{t}{t_0} \quad (1)$$

to represent the data where Q and t_0 are constants and x is the cumulative excretion as a function t . Haigh and Reiss's equation is

$$x = x_{\max.} \{1 - \exp(-\lambda t)\} \quad (2)$$

where $x_{\max.}$ and λ are constants. Plotting Haigh and Reiss's equation in the manner of Stern gives an effective straight line over the range $t = 0.2/\lambda$ to $t = 4/\lambda$, and this curve then has a discontinuity and becomes the horizontal straight line $x = x_{\max.}$ for greater times. This straight line yields values of $Q = a x_{\max.}$ and $t_0 = b/\lambda$; tentative values of the constants a and b are $a = 0.25$ and $b = 0.1$. For values less than $0.2/\lambda$, the curve tends to the straight line $x = 0$ as t tends to zero. This behaviour is more satisfactory than the straight line of Stern, as the latter will yield negative excretions for the period immediately after the injection. Thus it appears that in fact Stern's method is merely a convenient way of plotting a Haigh-Reiss formula.

In the case of Stern's curves (C and D), there appears to be some evidence for a discontinuity of the type predicted by a Haigh and Reiss formula, except that the second straight line is not horizontal but instead has a smaller slope than the first line. Our own experiments with inulin give curves of the same type as D , and in this case a study was also made of the plasma concentration, C_1 , which could be represented by an equation

$$C = C_1 \exp(-\lambda_1 t) + C_2 \exp(-\lambda_2 t) \quad (3)$$

where C_1 , C_2 , λ_1 and λ_2 are constants. Assuming simple glomerular filtration, equation (3) would yield a double Haigh-Reiss formula of the form

$$x = x_1 \{1 - \exp(-\lambda_1 t)\} + x_2 \{1 - \exp(-\lambda_2 t)\} \quad (4)$$

where x_1 and x_2 are constants. Such a formula when plotted in the manner of Stern yields a curve of type D , and it is possible to evaluate the four constants x_1 , x_2 , λ_1 , λ_2 , from an analysis of the curve.

In the case of inulin, equation (3) is a mathematical representation of the combined effect of passage of inulin into (and out of) the interstitial fluid and glomerular filtration. Thus the constants in equations (3) and (4) are related to physiological factors in the case of inulin, and probably in the cases studied by Stern.

J. HOUGH

University, Hull.

H. BARNARD

O. BASSIR

Area Pathology Laboratory,
Westwood Hospital,
Beverley, Yorks.

¹ Stern, B., *Nature*, 175, 258 (1955).

² Haigh, G. P., and Reiss, M., *Brit. J. Radiol.*, 23, 538 (1950).

I AM grateful to Hough, Barnard and Bassir for suggesting that my equation may be considered as an approximation, over a limited range of t , to that described by Haigh and Reiss. This explanation may provide some logical justification for what was an empirical finding.

Fig. 1 shows a graphical representation of the Haigh and Reiss equation (solid curve); plotted on a log time-scale, together with the limits over which Hough *et al.* suggest a line of the form of my equation may be considered as a good approximation (marked G). Their suggestion that $x = x_{\max.}$ for large values

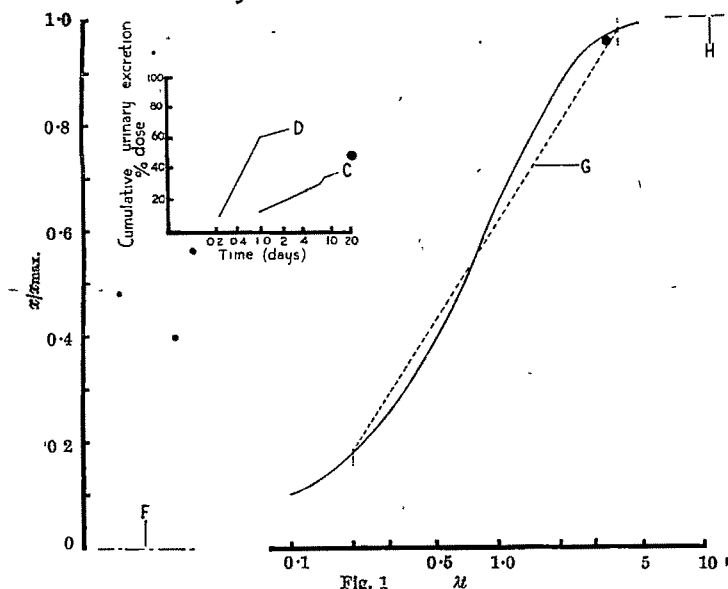


Fig. 1

of t is shown as the broken line H , and $x = 0$ when t is small as F . Their argument that the inset curves C and D provide some evidence for the existence of lines G and H is perhaps more debatable, and it appears to be more likely that these discontinuities are manifestations of changes in excretion-rate parameters.

There is one further point: their argument leads Hough *et al.* to the formula $Q = a \cdot x_{\max}$, where $a \doteq 0.25$. For line B of my original curve, $x_{\max}$ is evidently 100 per cent, so that the right-hand side of this equation is approximately 25 per cent. Q may be read from the slope of the line, and is approximately 22 per cent, and these two percentages are close enough to support the hypothesis of Hough *et al.* for this line.

When, therefore, there is evidence that the urinary excretion of a substance may be expressed by Haigh and Reiss's equation, Hough *et al.*'s suggestions provide a neat method of evaluating $x_{\max}$ and λ from a graphical representation of my equation, the former being obtained from the 'double time factor' ($x_{\max} = Q/a$) and the latter from the intercept of the line on the time axis ($\lambda = b/t_0$), when the cumulative urinary excretion is plotted against log time.

BABETTE E. STERN

Marie Curie Hospital,
London, N.W.3.
March 3.

The Binding of Vitamin B₁₂ by Castle's Intrinsic Factor

Ternberg and Eakin observed that gastric juice rendered vitamin B₁₂ unavailable to micro-organisms. Much attention has since been given to the binding of the vitamin by mixtures of substances, some of which possess intrinsic factor activity, and also by certain proteins, such as lysozyme, and heparin. However, it has been shown by several workers¹ that intensity of binding is not necessarily correlated with intrinsic factor activity. It was shown by Bird and Hoefvet that a great variation in vitamin B₁₂-

binding capacity of their intrinsic factor concentrate could be demonstrated, depending on the technique employed.

The following experiments have been carried out to determine the binding of vitamin B₁₂ by a preparation of Castle's intrinsic factor². The binding of vitamin B₁₂ was determined by adding excess vitamin to solutions of a preparation of the intrinsic factor. Two types of experiment were performed: one in which free vitamin B₁₂ was determined in the presence of the complex, and another in which the solution was ultrafiltered and the free vitamin determined in the ultrafiltrate. In all experiments the vitamin B₁₂ was determined microbiologically, using a mutant *Escherichia coli* in plate assay. The results are shown in Table 1.

It will be observed that two concentrations of vitamin B₁₂ were combined with a single concentration of intrinsic factor concentrate, and similarly, two concentrations of intrinsic factor were combined with a single concentration of vitamin B₁₂. The effect of doubling either of these two variable factors, while keeping the other one constant, could thereby be observed.

Some of the determinations were made by the ultrafiltration method described above. The values obtained by the two methods were of the same order. Free B₁₂ estimated in the presence of the complex could not therefore be attributable to utilization of bound vitamin B₁₂ by *E. coli*. These experiments are not comparable with the dialyses of Bird and Hoefvet, in which the complex of vitamin B₁₂ and binding factor was, in effect, being constantly washed. In the ultrafiltration experiments the complex was being concentrated, whereas the concentration of free vitamin within and without the sac remained the same.

Thus, by doubling the initial concentration of intrinsic factor concentrate from 52.5 $\mu\text{gm. per ml.}$ to 105 $\mu\text{gm. per ml.}$, while keeping the vitamin at the constant concentration of 100 $\mu\text{gm. per ml.}$, it was possible to increase the binding of the vitamin from a mean value of 47.5 $\mu\text{gm.}$ to one of only 66.2 $\mu\text{gm. per ml.}$, instead of approximately 100 $\mu\text{gm.}$. The respective specific binding activities were 896 $\mu\text{gm. per mgm. intrinsic factor concentrate}$ and 630.5 $\mu\text{gm. per mgm. intrinsic factor concentrate}$; thus the lowest level of vitamin B₁₂

Table 1. SUMMARY OF B₁₂ BINDING BY INTRINSIC FACTOR

Intrinsic factor ($\mu\text{gm./ml.}$)	Vitamin B ₁₂ ml. added	Vitamin B ₁₂ /ml. bound	Specific binding capacity ($\mu\text{gm. B}_{12}/\text{mgm. intrinsic factor}$)
105 $\mu\text{gm.}$	100 $\mu\text{gm.}$	70 $\mu\text{gm.}$	666
		70	666
		60	571
		65	619
52.5 $\mu\text{gm.}$	100 $\mu\text{gm.}$	55 $\mu\text{gm.}$	1,037
		45	849
		45	849
		45	849
52.5 $\mu\text{gm.}$	200 $\mu\text{gm.}$	100 $\mu\text{gm.}$	1,886
		110	2,075

* Results obtained by the ultrafiltration method.

gave a higher apparent specific activity. Using 52.5 μ gm. of intrinsic factor concentrate, combined with 100 μ gm. and 200 μ gm. of vitamin B₁₂, the binding values obtained were 47.5 μ gm. per ml. and 105 μ gm. per ml. respectively. The specific binding activity was thus raised from 896 μ gm. to 1,980 μ gm. per mgm. of intrinsic factor concentrate.

These results show that the use of vitamin B₁₂ binding by a substance or the vitamin content of a complex in following the isolation of B₁₂-binding proteins may be subject to a number of confusing variations. Gregory and Holdsworth³ conclude that their cyanocobalamin-protein isolated from sow's milk is very similar to that isolated from hog gastric mucosa by Wijmenga *et al.*⁴. They noted only one discrepancy, and that was in the content of vitamin B₁₂; the former contained 12.3 μ gm. per mgm. and the latter 23.6 μ gm. per mgm. It is doubtful whether or not such results possess any absolute value, and it would seem certain that deductions concerning molecular weights are meaningless.

The present results are of interest in the light of clinical observations which demonstrate that an increase in either the amount of vitamin B₁₂ or of intrinsic factor enhance the hamatopoietic effect of their simultaneous oral administration. It is possible that the increase in binding of vitamin B₁₂, observed when the concentration of either the vitamin or the intrinsic factor concentrate was increased, might bear some relation to an increased absorption of the vitamin.

This work was carried out during the tenure of a Luccock Fellowship from the Medical School, King's College, University of Durham. I wish to thank Dr. A. L. Latner for his advice and encouragement.

LAUREEN RAINE

Department of Pathology,
Royal Victoria Infirmary,
Newcastle upon Tyne 1,
Dec. 13.

¹ Prusoff, W. H., Meacham, G. C., Heinle, R. W., and Welch, A. D., Abstracts 118th meeting Amer. Chem. Soc., Chicago, September 8 (1950), p. 27 A. Hall, B. B., *Brit. Med. J.*, ii, 585 (1950). Latner, A. L., and Raine, Laureen (unpublished work).

² Latner, A. L., Merrills, R. J., and Raine, Laureen, *Lancet*, i, 497 (March 6, 1954).

³ Gregory, Margaret E., and Holdsworth, E. S., *Nature*, 173, 830 (1954).

⁴ Wijmenga, H. G., Thompson, K. W., Stern, K. G., and O'Connell, D. J., *Biochim. et Biophys. Acta*, 13, 144 (1954).

Effect of Splenectomy on 'Antrycide' Therapy of *Trypanosoma evansi* Infection in Rats

'ANTRYCIDE', a trypanocidal drug which has been reported to be inactive *in vitro*, exerts marked chemotherapeutic activity *in vivo*¹. This difference in activity of 'Antrycide' *in vitro* and *in vivo* may possibly be due to the drug being converted to a more active metabolic degradation product than the parent drug, or activated *in vivo* through the intervention of the reticulo-endothelial system. The first of these possibilities cannot be excluded in the present state of knowledge, as very little is known about the metabolic degradation products of 'Antrycide'. This communication presents evidence to support the latter view that the reticulo-endothelial system plays an important part in the chemotherapeutic activity of 'Antrycide' (methylsulphate salt) against *T. evansi*

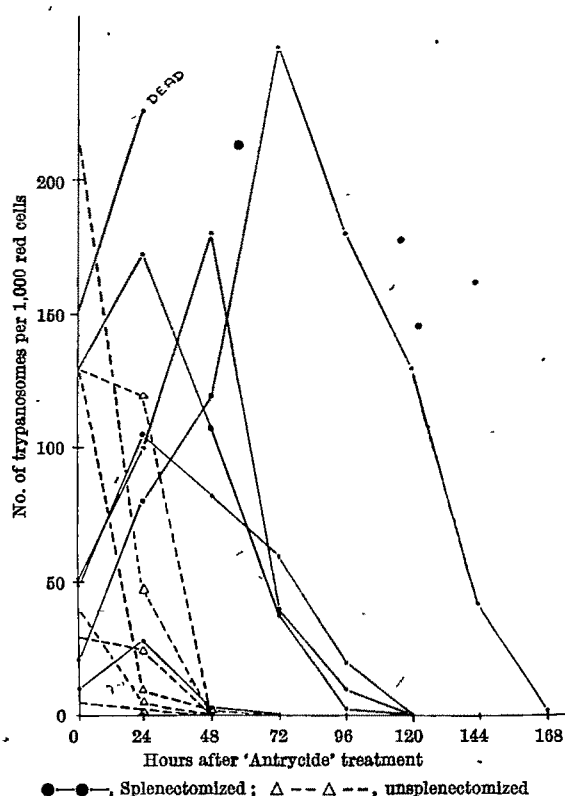


Fig. 1. Graph illustrating the course of *T. evansi* infection in splenectomized and unsplenectomized rats after 'Antrycide' therapy

in rats. The strain of *T. evansi* is of equine origin, isolated at the Indian Veterinary Research Institute in 1945, and being maintained through blood passages in rats.

Three sets of experiments were conducted, rats being used in each set. Twelve animals were divided into two homogeneous groups, one of them being splenectomized, while the others served as unsplenectomized controls. Ten days after the operation, each of the splenectomized and the control animals was infected with about 10×10^6 trypanosomes by the subcutaneous route. The course of infection in both groups was followed by daily examination of thin and thick blood smears. No appreciable difference in the prepatent period and the course of parasitaemia was observed in the two groups. During the acute phase of the infection, they were treated with 'Antrycide methylsulphate' (3 mgm./kgm.) by the subcutaneous route. Twenty-four to seventy-two hours after treatment, the flagellates disappeared from the blood of the control rats, whereas it was 72–192 hr. before they disappeared from the circulation in splenectomized ones. 'Antrycide' administered when the density of trypanosomes was fairly high could not control the progressive multiplication of the flagellates in some of the animals. The results of one set of experiments are illustrated in Fig. 1.

Similar experiments were undertaken in rats which relapsed within three to five weeks after control of the primary attack with 'Antrycide' (3 mgm./kgm.). When a fair number of organisms appeared in the peripheral circulation, about half these cases were treated with a second dose of 'Antrycide' (3 mgm./kgm.), while the remaining half were splenectomized

and treated with 'Antrycide'. The rate of disappearance of parasitaemia with the splenectomized group was also much prolonged as compared to the unsplenectomized ones.

The above results suggest that the reticulo-endothelial system participates in the chemotherapeutic activity of 'Antrycide'. Its action is similar to trypanocidal drugs like suramin in this respect, as the activity of the latter has been found to be bound up with the reticulo-endothelial system². But the exact mode of participation of the reticulo-endothelial system, that is, (1) whether the drug acts chiefly in stimulating the immunity, or (2) indirectly kills the organism by an opsonin-like reaction, or (3) facilitates a longer drug-parasite contact, is still not clearly understood. Work is in progress to explore the above possibilities.

The award of a Research Scholarship to one of us (H. G. S.) by the Indian Council of Agricultural Research is gratefully acknowledged.

H. G. SEN
B. N. DUTTA
H. N. RAY

School of Tropical Medicine,
Calcutta 12.

¹ Ormerod, W. E., *Brit. J. Pharmacol. and Chemother.*, **6**, 325 (1951).

² Krltschewski, J. L., *Z. Immunforsch.*, **59**, 1 (1928). Jancso, N. von, and Jancso, H. von, *ibid.*, **84**, 471 (1935).

Resistance to Colicin E as a Genetic Marker in *E. coli* K12

As many genetic markers as possible are needed for the elucidation of possible mechanisms by which bacterial recombination occurs.

A whole group of potential markers is available in the colicins. These are antibiotics produced by some *E. coli* strains, which can inhibit the growth of other strains of the same or closely related species¹. Unfortunately, none of these substances has been obtained pure, so that they cannot be used as selective agents during the recombination technique but only as unselected markers with which the parent strains and their progeny can be labelled. Several of the colicins produce wide zones of inhibition with sensitive strains and are therefore possible useful markers². In particular, colicin E possesses all the requirements of a good marker and its linkage to other known markers can be studied.

The strains of *E. coli* used were the wild-type K12 strain which grows on inorganic salt medium with glucose (minimal medium)³, strain 58.161 requiring methionine (M-) for growth, and strain W677 requiring threonine (T-), leucine (L-) and thiamine (B₁-) for growth; both F⁺ and F⁻ types of these strains were used. All these strains are sensitive to colicin E, and resistant mutants were selected by inoculating approximately 10⁸ cells of the parent strain on to nutrient agar plates containing 10 per cent of a 24 hr. broth filtrate of the colicin E-producing strain CA38. Recombinations were carried out and the progeny tested by the techniques described previously⁴. Colicin E sensitivity of the recombinants was tested by the method of Fredericq⁵.

The results of four recombination experiments in which the mixture of the washed parent strains was seeded on to different selective media are shown in Table 1. In the first two crosses, in which W677 was the F⁻ parent, selection for T⁺, L⁺ and B₁+

Table 1. ANALYSIS OF RECOMBINANTS

Cross	Supplements to minimal medium	Recombinants (Nos.)	% B ₁	% colicin E ^R
58 ER × W/F-	None	88	—	75
	B ₁	600	55	2
	Lactose	50	—	66
K12 ER × W/F-	Lactose B ₁	200	52	14
	Strep.	500	—	82
	Strep. B ₁	800	70	14
58/F+ × W ER/F-	Strep. lactose	400	—	92
	Strep. B ₁ lactose	600	96	24
58/F+ × W ER/F-	None	100	—	50
	B ₁	600	?	94
	Lactose	50	—	58
W ER/F+ × 58/F-	B ₁ lactose	200	?	93
	None	150	—	56
	B ₁	175	?	90

by seeding the mixture on to unsupplemented minimal medium yields a progeny of which 75–82 per cent is resistant to colicin E. Addition of thiamine to the selecting medium, which allows B₁-dependent colonies to grow, greatly increases the number of recombinants, and of these only 2–14 per cent are resistant to colicin E. There is evidently an association or linkage between the B₁+ and ER characters of the F⁺ parent. The cross of W677 ER/F- with 58.161/F+, in which the F- parent carries the marker for colicin E resistance, gives results which are in agreement with the localization of the ER locus close to that of B₁. In this case, when selection is for T⁺, L⁺ and B₁+, the locus for colicin E sensitivity is present in 50 per cent of the progeny. Removal of selection for B₁+ reduces this to 6 per cent, that is, 94 per cent of the progeny have the ER locus of the F- parent. The cross of W ER/F+ with 58.161/F- also yielded concordant results; in this instance, selection for M+ carries over 56 per cent of colicin ER; addition of B₁ to the selecting medium gives a progeny 90 per cent of which is ER. The loci for M and B₁ in 58.161 are known to be closely linked⁶, and the greatly increased transfer of ER when survival of the B₁- marker of 58.161 is allowed shows that the locus for colicin ER lies between the loci for M and B₁.

C. R. JENKIN
D. ROWLEY

Wright-Fleming Institute of Microbiology,
St. Mary's Hospital Medical School,
Paddington, London, W.2.
Dec. 31.

¹ Gratia, A., *C.R. Soc. Biol. (Belg)*, **93**, 1040 (1925). Fredericq, P., *C.R. Soc. Biol.*, **138**, 395 (1944).

² Fredericq, P., *C.R. Soc. Biol.*, **145**, 1436 (1951).

³ Davis, B. D., and Mingioli, E. S., *J. Bact.*, **61**, 17 (1950).

⁴ Clowes, R. C., and Rowley, D., *J. Gen. Microbiol.*, **11**, 27 (1954).

⁵ Fredericq, P., thesis, University of Liège (1948).

⁶ Hayes, W., *J. Gen. Microbiol.*, **8**, 72 (1953).

A *Limax-Amoeba* from the Rectum of the Grass Snake, *Natrix natrix*, as a Facultative Aerobe *in vitro*

ALTHOUGH small amoebae of the *Limax*-type appear fairly commonly in cultures initiated from standing faeces or the intestinal contents of animals, in only a very few cases has the truly entozoic status of the amoebae thus recovered been authenticated. The test hitherto has been the direct observation of the trophic amoebae in host material, either in fresh

preparations (for example, *Vahlkampfia lacertae* (Hartm.) from the large intestine of *Lacerta muralis*¹ and an unnamed amoeba seen by Mackinnon² in the intestine of a Tipulid larva) or in fixed and sectioned material (for example, *V. discorbin* Calv.³, parasitic in the Foraminiferan, *Discorbis mediterraneensis*). Nevertheless, the frequent occurrence of *limax*-amoebae as presumptive anaerobes, or, at least, facultative anaerobes, makes it tempting to suppose that some of them are also facultative parasites. Yet, so far, little experimental investigation of the status of *limax*-amoebae has been reported. The following is a preliminary account of a strain, called *Am*, of *limax*-amoebae isolated in this laboratory in June 1953.

A washing from the rectum of a living grass-snake, *Natrix natrix*, was inoculated into Ehs medium⁴; the amoeba was detected three days later, isolated from accompanying flagellates, and has lived easily and in good health *in vitro* ever since. The trophic organism is a typical *limax*-amoeba, with a single nucleus containing a large karyosome, and ordinarily using a single, broad pseudopodium during movements of translation. Its only remarkable feature is the small size, the mean diameter of two hundred rounded specimens being 5.5μ ; the cysts are elliptical, thick-walled and refringent, uninucleate, $5.5\mu \times 3.5\mu$ (mean of 200). No flagellated phase has yet been detected. The identity of the amoeba has yet to be determined: it appears at present to differ from all recorded species in its minute size, and from most in the shape of the cyst.

When grown in upright tubes of medium containing dilute horse serum fortified with 'Marmite'⁵ or in Boeck tubes of Ehs medium, the organism can be recovered from the bottom of the liquid (that is, the normal site for parasitic anaerobes such as *Entamoeba* spp.) for three-four days, and then normally disappears; but on the surface of the liquid it flourishes for at least twenty days. On nutrient agar, or non-nutrient agar spread with *Aerobacter*⁶, it survives as on the surface of liquid media. Cysts were formed on liquid and solid media. To explore the oxygen requirements further, ten tubes of horse serum with 'Marmite' medium containing fresh sub-cultures of the amoeba were set up in pairs in five McIntosh and Fildes anaerobic jars, A-E. All were exhausted of air, and A-D were filled with hydrogen, E with oxygen. Tubes were withdrawn from A, B, C and D for examination on the second, third, fifth and twenty-first days respectively; the two tubes in E were taken out and examined on each of these days and, on the first three, replaced in oxygen. In every tube, healthy, active trophic amoebae were found, showing complete tolerance of either atmosphere.

Attempts to infect three clean hosts (*N. natrix*) orally with cysts and trophic amoebae were unsuccessful. Of attempts to infect two clean hosts rectally with cysts, one was negative and one positive, the infection lasting seventeen days and then dying out. Two attempts to infect hosts rectally with trophic amoebae were successful, the infections being maintained until the animals died ten and twenty-one days after being inoculated.

When living on the surface of liquid media or on agar, the organism behaves like an ordinary free-living *limax*-amoeba; indeed, non-nutrient agar with *Aerobacter* was the medium devised by Singh specifically for small soil amoebae. In the snake, at the bottom of liquid media, and in hydrogen, the organism behaves like a typically entozoic anaerobe. It is to

be regarded as completely facultative in habit and respiratory requirement.

A full account of the experiments will appear elsewhere, together with the results of other work now in progress. I wish to thank Dr. Brendan Moore, of the Public Health Laboratory, Exeter, for allowing me the use of his battery of McIntosh and Fildes jars.

R. S. J. HAWES

Department of Zoology,
University College,
Exeter.
Dec. 30.

¹ Dobell, C., *Arch. Protistenk.*, 34, 139 (1914).

² Mackinnon, D. L., *Arch. Protistenk.*, 32, 267 (1914).

³ Le Calvez, J., *Arch. Zool. exp. et gén.*, 81, 123 (1940).

⁴ Dobell, C., and Laidlaw, P. P., *Parasitol.*, 18, 283 (1926).

⁵ Jones, W. R., *Ann. Trop. Med. Parasit.*, 40, 130 (1946).

⁶ Singh, B. N., *Nature*, 165, 65 (1950); *Phil. Trans. Roy. Soc., B*, 236, 405 (1952).

Use of Liquid Propane as Refrigerant

IN discussing the precautions required when liquefying propane for use as a refrigerant for biological specimens, J. L. Stevenson¹ points out, and correctly, the necessity for preventing the simultaneous liquefaction of air. However, this liquefaction does not occur at the boiling point of oxygen, 90° K., as would be inferred from his communication, but only at temperatures below the dew point of air, which is about 82° K.

While at 86° K. a second liquid layer cannot be formed by condensation of air, it is still possible that such a layer might be produced by solution. We have been unable to find any report of data for the system propane/oxygen at 90° K.; but, from the data referring to similar systems, we estimate the solubility of oxygen in liquid propane to be about 2 per cent, which is safely below the explosive limit.

We have made extensive use of liquid propane as the bath liquid for low-temperature cryostats without ill-effects. The liquid is contained in a double-walled vessel immersed in liquid nitrogen, the space between the walls being filled with helium gas. Thus the interior is at a temperature appreciably higher than that of the liquid-nitrogen bath. In filling gaseous propane is passed through a cooled spiral in which it condenses, so that liquid at low temperature (about 95° K.) is run into the vessel. Final cooling occurs therein down to temperatures as low as 86° K., at which temperature liquefaction of atmospheric oxygen will not occur. In our opinion it is undesirable to allow liquefaction to occur in an open vessel where heat exchange is likely to be poor owing to the large amount of combustible gas liberated.

We would also mention that in our experience hazards can occur when it is necessary to undertake glass-blowing operations on apparatus that has held liquid propane or similar combustible materials. Great care must then be exercised to ensure that traces of these materials are removed from the apparatus before working on it.

A. H. COCKETT

Research and Development Department,
The British Oxygen Co., Ltd.,
Deer Park Road,
London, S.W.19.
Dec. 29.

¹ Stevenson, J. L., *Nature*, 174, 235 (1954).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, May 2

SOCIETY OF ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. E. R. Sherrington: "American Railways and Their Modern Technical Developments".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting, followed by Dr. A. J. E. Welch: "The Inorganic Chemistry of Complex Metal-Oxide Systems".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Sir Miles Clifford: "The Falkland Islands and Their Dependencies".

Tuesday, May 3

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St Mary's Hospital Medical School, London, W.2), at 5 p.m.—Sir Zachary Cope: "Some Peculiarities of the Clinical Pathology of Actinomycoses" (Almroth Wright Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Prof. W. V. Mayneord: "Medical Uses of Radioactive Isotopes".

Wednesday, May 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Major Oliver Stewart: "New Ways of Flying" (Trueman Wood Lecture).

EUGENIOS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Prof. Sir Cyril Burt: "The Meaning and Assessment of Intelligence" (Galton Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the INSTITUTION OF CIVIL ENGINEERS and the INSTITUTION OF MECHANICAL ENGINEERS, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Sir Harold Hartley, F.R.S.: "The Engineers' Contribution to the Conservation of Natural Resources" (First Graham Clark Lecture).

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

ROYAL AERONAUTICAL SOCIETY, GRADUATES' AND STUDENTS' SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. E. J. Catchpole and Mr. W. J. Eggington: "Technical Aspects of Supersonic Aircraft Design".

Thursday, May 5

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 10.30 a.m.—Discussion on "Magneto-Hydrodynamics", opened by Sir Edward Bullard, F.R.S.

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. C. F. A. Pantin, F.R.S.: "Terrestrial Nemertines and Convergent Evolution".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. W. Grey Walter: "The Electrical Activity of the Brain".

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. G. P. Wells, F.R.S.: "The Sources of Animal Behaviour".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (in the Large Hall of the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6 p.m.—Annual General Meeting, 6.15 p.m.—Dr. H. G. Thornton, F.R.S.: "Recent Advances in Soil Microbiology".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, May 6

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Three Great Natural Philosophers—Gilbert, Hooke, Newton". (Further lectures on May 9 and 11.)

ROYAL METEOROLOGICAL SOCIETY, MANCHESTER CENTRE (at the University, Manchester), at 6.30 p.m.—Prof. G. Manley: "Climatic Fluctuation—Field Evidence and Mathematical Frolics".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 8 p.m.—Dr. F. P. Bowden, F.R.S.: "Fast Reactions in Solids and the Birth and Growth of Explosions".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—Prof. R. M. Barrer, Chemistry Department, Imperial College, London, S.W.7 (May 3).
READER IN GEOLOGY at King's College, Strand, London, W.C.2—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 5).

RESEARCH OFFICER (honours graduate with adequate teaching experience, and preferably with an academic qualification in psychology or education), for work in secondary schools, with special reference to technical education—The Director, National Foundation for Educational Research, 79 Wimpole Street, London, W.1 (May 6).

ASSISTANT LECTURER or LECTURER (preferably with specialist knowledge of systematic botany) in the DEPARTMENT OF BOTANY, and an ASSISTANT LECTURER in the DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Liverpool (May 7).

ASSISTANT LECTURER (with special qualifications in organic chemistry) in CHEMISTRY—The Registrar, The University, Manchester 13 (May 7).

ASSISTANTS (2) (preferably with an honours degree in bacteriology or equivalent qualification) in the DEPARTMENT OF BACTERIOLOGY, to take part in the lecturing and advisory work of the department—The Secretary, North of Scotland College of Agriculture, 414 Union Street, Aberdeen (May 7).

PHARMACOLOGIST (with a first- or second-class honours degree or equivalent qualification in physiology or pharmacology, and preferably familiar with modern methods of separation, identification, and assay of active principles in biological fluids), at a Ministry of Supply Establishment, near Salisbury, Wilts, for experimental work concerned with determining the mode of action of drugs and the assessment of therapeutic measures—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.111/5A (May 7).

SENIOR LECTURER (with high academic qualifications and some research experience, preferably in industry) in ELECTRONICS—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (May 7).

DEMONSTRATOR (with at least a good honours degree) in the PHYSICS DEPARTMENT of University of London King's College, for duties which include devising new experiments, organizing and demonstrating in the practical classes of degree courses—The Registrar, King's College, Strand, London, W.C.2 (May 9).

SENIOR LECTURER IN MATHEMATICS—The Principal, Newland Park Training College, Chalfont St. Giles, Bucks (May 10).

ASSISTANT LECTURER (female) (preferably with special interests in plant ecology and/or plant morphology) in BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (May 14).

LECTURER IN MATHEMATICAL STATISTICS, a LECTURER in BIOCHEMISTRY, a LECTURER or ASSISTANT LECTURER in PSYCHOLOGY (with special reference to physiological aspects), an ASSISTANT LECTURER in PURE MATHEMATICS, and an ASSISTANT LECTURER or RESEARCH ASSISTANT in VIRUS DISEASES—The Secretary, University College, Exeter (May 14).

LECTURER (with a good honours degree and an interest in the history and philosophy of science) in EDUCATION—The Registrar, The University, Sheffield (May 14).

ASSISTANT LECTURERS and DEMONSTRATORS in the DEPARTMENTS of BACTERIOLOGY, NUTRITION and PHYSICS—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8 (May 20).

ASSISTANT IN BOTANY—Secretary of University Court, The University, Glasgow (May 21).

ASSISTANT LECTURER (with special interests in the field of cartography) in GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (May 21).

LECTURER or ASSISTANT LECTURER (suitably qualified graduate with experience in one or more of the following fields: measurements, D.C. and A.C. machinery, servo-mechanism, high vacuum technique, engineering acoustics, electronic circuit technique or communications) in the DEPARTMENT OF ELECTRICAL ENGINEERING—The Registrar, The University, Manchester 13 (May 21).

PROFESSOR (with good academic qualifications and practical experience) OF ELECTRONICS, at Madras Institute of Technology—High Commission of India, Establishment Department, Aldwych, London, W.C.2, quoting 4/86D (May 21).

SENIOR ASSISTANT IN RESEARCH within the DEPARTMENT OF ENGINEERING, to work on a project concerning heat transfer in liquid metals—The Secretary of the Appointments Committee, Engineering Laboratory, University of Cambridge, Trumpington Street, Cambridge (May 21).

LECTURER IN MATHEMATICS—The Secretary, The University, Birmingham 15 (May 23).

PLANT BREEDER, Senior Scientific Officer or Principal Scientific Officer grade (with a good honours degree and practical experience)—The Secretary, Glasshouse Crops Research Institute, Worthing Road, Rustington, Littlehampton, Sussex (May 23).

TECHNICAL OFFICER (with a degree in science or engineering or equivalent qualifications, and preferably with experience in coal utilization research) in the COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, to assist in investigations into the combustibility and reactivity of coals and cokes—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/165 (May 27).

LECTURER (graduate in metallurgy or chemistry and with special qualifications in spectroscopic or other modern analytical techniques, and preferably with experience in metallography) in METALLURGY—The Registrar, The University, Manchester (May 31).

ZOOLOGIST, Scientific Officer grade (with general research experience), to do research on quantities of zooplankton in the sea and their fluctuations in relation to the environment—The Secretary, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth, Devon (May 31).

NUFFIELD FELLOW (with suitable postgraduate experience, and detailed knowledge of the structure of at least one foreign European language) in the COMPUTATIONAL LABORATORY, for work on problems connected with the use of computing machines for mechanical translation—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (June 15).

CHAIR OF STEAM ENGINEERING AND REFRIGERATION in the Faculty of Engineering, Alexandria University—The Dean, Faculty of Engineering, Alexandria, Egypt (June 20).

PROFESSOR (with a good honours degree and preferably with research experience in plant pathology, systematic botany or genetics) OF BOTANY, a READER (with a good honours degree and research experience in soil physics or soil chemistry) in SOIL SCIENCE AND

NATURE

No. 4462

SATURDAY, MAY 7, 1955

Vol. 175

CONTENTS

	Påge
Adult Education	783
The British Museum <i>Archaeopteryx</i> . By Prof. D. M. S. Watson, F.R.S.	785
Genesis of Modern Science. By Dr. William P. D. Wightman	785
Modern Physical Metallurgy. By Prof. A. G. Quarrell	786
A Geochemical Classic. By Prof. Arthur Holmes, F.R.S.	787
Chemical Industry and Air and Water Pollution	790
The Experimental Approach to Thinking. By Prof. John Cohen	792
A New Aether-drift Experiment. By Dr. L. Essen	793
Obituaries :	
The Rev. Pierre Teilhard de Chardin, S.J. By Sir Wilfrid Le Gros Clark, F.R.S.	795
Dr. Julius Podolanski. By Prof. L. Rosenfeld	795
News and Views	796
Mathematical Association : Annual Meeting.	800
Hydraulic Conveying of Solids. By Prof. D. M. Newitt, F.R.S., and J. F. Richardson	800
Embryology of Mammals. By Prof. S. Zuckerman, C.B., F.R.S.	801
Electrical Properties of Wood	802
Cacao Research	802
Micro-fossils in Early Floras	803
Respiratory Pigments of <i>Rhodospirillum rubrum</i> . By Dr. Britton Chance and Dr. Lucile Smith	803
Application of Biometric Methods to Problems of Classification in Ecology. By R. Ellyn Hughes and D. V. Lindley	806
Letters to the Editors :	
The Horizon of the Steady-State Universe.—F. Hoyle	808
A Radio Survey of the Great Loop in Cygnus.—D. Walsh and R. Hanbury Brown	808
Absorption of Underwater Sound by Substances in Process of Solution.—Dr. R. D. C. Reed and T. S. McLeod	809
Application of Nuclear Coincidence Methods to Atomic Transitions in the Wave-length Range $\lambda\lambda$ 2000–6000 Å.	
—Dr. Eric Brannen, F. R. Hunt, R. H. Adlington and Dr. R. W. Nicholls	810
Small-Angle X-Ray Diffraction Patterns of Collagen.—C. R. Worthington and Dr. S. G. Tomlin	811
Derivatives of Caffeic Acid in Sweet Potato attacked by Black Rot.—Dr. Ikuzo Uritani and Masateru Miyano	812
Development of Anopheles A Virus in the Endoplasmic Reticulum of Ehrlich Ascites Tumour Cells.—Marlene Friedlaender, Prof. Dan H. Moore, Robert Love, Ray A. Brown and Hilary Koprowski	812
Sequence of Sexual and Asexual Phases in <i>Anthamnion spirographidis</i> Schiffner.—Er. Kathleen M. Drew	813
Juvenility Phenomena associated with Crown Gall.—Dr. J. P. Hudson, M.B.E., and I. H. Williams	814
Cellulase and Chitinase in Soil Amœbæ.—M. V. Tracey	815
Extraction of Enchytraeid Worms from a Coniferous Forest Soil.—F. B. O'Connor	815
Pumilin, a New Antibiotic from <i>Bacillus pumilus</i> .—Dr. D. S. Bhate	816
Location and Innervation of the Corpus Cardiacum in the Larvæ of some Calliphorinae (Diptera).—Alastair Fraser	817
Putrescine as an Essential Growth Factor for a Mutant of <i>Aspergillus nidulans</i> .—P. H. A. Sneath	818
Extraction of Pigment from Cooked Cured-Meat Products.—J. I. Anderton and D. J. Locke	818
Mechanism of Sclerotin Formation : the Participation of a Beta-Glucoside.—P. C. J. Brunet and Dr. P. W. Kent	819
Reversal of the Fungicidal Effect of Dithiocarbamyl Compounds.—Jostein Goksøyr	820
Labelling Locusts with Radioactive Isotopes.—Dr. H. B. D. Kettlewell	821
Elution of Isoagglutinins adsorbed by Platelets.—Prof. J. Gurevitch and D. Nelken	822

Editorial and Publishing Offices of Nature

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number : Whitehall 8831. Telegrams : Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1

Telephone Number : Regent 3891.

All rights reserved. Registered as a newspaper at the General Post Office

ADULT EDUCATION

IN June 1953, the Minister of Education appointed a Committee to review the present system by which the extra-mural departments of universities, the Workers' Educational Association and the other responsible bodies provide local facilities for adult education. The Committee reported in August 1954 (*Nature*, 174, 865; 1954) and, after a long and searching analysis of the adult education movement of Great Britain, made recommendations to remove many of the frustrations which beset the voluntary organizations, university extra-mural departments, and full-time and part-time tutors, and which have led to much introspective discussion since the end of the War. The recommendations of the Committee have recently been considered by the Minister of Education, who, on April 8, announced in the House of Commons that he was able to agree with almost all its recommendations.

Among the recommendations of the Committee were that the Ministry's policy on adult education should always be such as to encourage voluntarism and that the Workers' Educational Association districts should be encouraged to preserve their status as responsible bodies and continue both to organize and to provide classes. Those in touch with adult education know that many of the difficulties with which the movement has had to grapple have arisen out of conflict, often politely concealed but none the less real, between organizations like the Workers' Educational Association and a number of university extra-mural departments.

The chairman of the Ministry of Education Committee was Dr. Eric Ashby, and in the William F. Harvey Memorial Lecture* at Fircroft College on March 24 he has personally carried the analysis of current adult education difficulties much farther than would be possible in an official report prepared by a committee.

Never has there been a more penetrating or more candid analysis of what Ashby sorrowfully calls the pathology of adult education; never has the case for voluntarism been more ably presented. With all the evidence before him, Ashby steps down from his official position and takes on the role of physician to a movement for which he has patently so great a regard.

After a historical review of the growth of the adult education movement in Britain and a commentary on its successive booms and slumps, Ashby carries out a meticulous diagnosis of the ills now so manifest in some sectors of the movement.

The decline in popularity of the Workers' Educational Association is due to the re-awakening of university extension. Formerly, the universities were content to do much of their extra-mural work through voluntary bodies. As some W.E.A. branches declined, enterprising university tutors moved in and, in a number of cases, set up *ad hoc* committees to organize classes direct. If universities and the

Workers' Educational Association had been equal partners, this kind of incident would have resulted in nothing more than healthy competition. Unfortunately, university extra-mural departments have access to funds which are not available to the W.E.A. In time a few university extra-mural departments found that it was simpler to arrange classes by dispensing altogether with the services of W.E.A. branches.

Although this kind of incident has happened only in a few areas in Great Britain, its implications have spread far beyond those regions and have injured the health of extra-mural work in the Workers' Educational Association and in the universities. One of the more unfortunate consequences of the internecine warfare between some branches of the W.E.A. and university extra-mural departments is that many friends of adult education who wish to contribute to its development have rightly refused to give allegiance to either side. They stand sadly aside with thoughts murmuring "a plague on both your houses".

In the W.E.A., the injury has resulted in a tendency for persistent and recurrent self-examination which is beginning to verge on hypochondria. At the end of the outbursts, the W.E.A. has had little to produce except the icons of the Association and what they stood for many years ago. Where liberal education classes for 'workers' have been difficult to organize, the line of least resistance has been taken and more 'popular' classes arranged.

Both extra-mural departments and Workers' Educational Association branches are defeatist about collecting reasonable fees from students. In many cases these are now no higher than they were forty years ago; at least one extra-mural director believes that classes should be completely free. This is not the view of Sir David Eccles who, in his statement in the House of Commons, said that he expected some further contribution towards the increased cost of adult education, either in the form of higher fees from students or in other ways.

These outward and visible signs of disorder are not chronic or incurable, but, in Ashby's words, "it is of the utmost importance that voluntary bodies engaged in adult education should rid themselves of these disorders in order that the spirit of voluntarism in British adult education may be preserved".

The symptoms of ill-health in university extra-mural departments take a different form; they are the symptoms of intellectual pride. "University extra-mural departments have already arrogated to themselves moral responsibility for liberal adult education in Britain. If you can persuade extra-mural directors to be frank, some of them will tell you that the W.E.A. is no longer necessary to interpret the university to the people; indeed that the Association is a survival of an obsolete class distinction and it actually puts some students off; that the universities are the architects of post-war adult education and they are carrying the voluntary bodies on their backs. You will hear that the first mission

* William F. Harvey Memorial Lecture, published by the Printer to the University, The Queen's University, Belfast, pp. 24 (1955).

of adult education was to be remedial, to reach the educationally under-privileged. You will be told that times have changed; that remedial education will become superfluous as the Welfare State develops; and that the universities should apply themselves to a new public: those who already have secondary or even tertiary education."

Although there is some truth in these assertions, there is not enough to justify a retreat from the principle that universities should conduct a large part of their extra-mural work through voluntary bodies. The symptoms themselves may spring from a new ailment in adult education, the pathology of a movement which enjoys too much security. Moreover, if university extra-mural departments are to be concerned with the products of higher education only, "who is to be responsible for adult education among the eight out of ten children who never enter a grammar school at all and among the nearly half a million children who at present leave school before their sixteenth birthdays?"

The resurgence of university extension work is accompanied by three dangers. First, adult education may become more and more professionalized. The original Workers' Educational Association tutorial classes were of university standard and taken by distinguished teachers like R. H. Tawney, A. L. Smith and A. D. Lindsay. Their place has been taken by a professional service of tutors: they are no longer men who teach in the university.

Frequently the tutors have little opportunity of mixing with their colleagues and "it is stretching a point to say that they 'come from the university' at all". While he may be a competent teacher, the professional tutor is likely to be a little less sympathetic with the voluntary groups on whose clumsy and sometimes ill-advised counsels his profession depends; and a little less critical of the genuineness of demands for classes when he has whipped up the demands himself. Too often these classes decline rapidly because they fail to satisfy real need. The Minister's announcement that higher salaries are to be paid to tutors of certain grades may enable university extra-mural departments to recruit from an enlarged field to include men who have had experience in ways of life other than teaching.

In days when many students are vitally interested in topics related to their work as supervisors or trade unionists in industry and commerce, too many classes are taken by tutors who have had little genuine contact with industry; they are about as effective as doctors would be if their studies had embraced anatomy and physiology but they had failed to 'walk the wards'. Many existing tutors served their movement well in days when most classes were concerned with economics, history and philosophy. With the challenge to provide classes in various aspects of industrial relations and organization, extra-mural departments and the voluntary organizations might well consider whether their movement might not be better served by the greater use of more part-time tutors drawn from industry—men whose teaching would be constantly illuminated by examples drawn from their daily practical experience.

Secondly, the resurgence of university extension work to the detriment of work by voluntary bodies may in the long run identify adult education too closely with academic education. Extra-mural tutors need to compensate for the decay of craftsmanship in industry, to equip adults to use some of their leisure to keep alive standards of excellence in crafts, in music played at home, and in the amateur practice of the fine arts. There is also the danger that extra-mural tutors seek to pass on to their students the compartmental specializations which they themselves have absorbed under a university system codified for examination purposes. Universities too often forget that examinable knowledge is not the only knowledge. This may explain the paucity of science-teaching in adult education. Science, with all its fascination, is often neglected in adult education because tutors can teach it only as they learnt it, and "this requires laboratories, equipment, a jargon of terms, a familiarity with technique". Science in adult education could be taught quite differently. What the citizen should know about chemistry and biology can be acquired without ever going into a laboratory: but only through new methods of teaching which the universities are not likely to evolve themselves.

Thirdly, there is the danger that adult education may become a social service like national insurance, 'laid on' by the university in a spirit of efficient paternalism. Educational shock troops descend on a district and create a demand by means of bright pioneer classes. These are followed by tutors offering more sustained and more advanced classes. Too often these classes decline rapidly because they fail to meet real need. The danger is that the voluntary spirit may disappear from adult education.

Ashby's inquiry does not end with pathology. If the techniques of adult education are to retain liveliness, they must be directed to the solving of immediate problems. When these problems are solved the techniques are likely to become out-moded, and adult education can maintain its virility only by turning to fresh problems and devising fresh techniques to solve them. The driving force behind the tutorial class movement was to win social emancipation and to fit the worker to take political responsibility. Social emancipation and political responsibility have now been acquired. New problems have emerged. The chief problem, as Ashby trenchantly says, "is that we live in a society which confers on the worker (irrespective of whether he is manual or clerical and irrespective of the amount of education he has) political responsibility, civic rights and leisure. The contemporary problem in adult education is that among many people at all levels of education the leisure is without purpose, the civic rights are without significance, and the political responsibility is assumed without understanding; social emancipation without personal emancipation is of little value. To preserve man's status as an individual is the contemporary task for adult education; techniques are needed for achieving personal emancipation among students".

The first prerequisite for the healthy survival of adult education in Britain is the presence of thousands of small voluntary groups. The second is that the

voluntary group should have its own roof over its head. In addition, a more realistic policy is needed in the part of those who organize adult education. There is evidence that serious education will never appeal to more than a very small minority. Insipid forms of educational amusement are much more efficiently provided by the techniques of mass education (the film society, the B.B.C. Third Programme and television) than by the techniques of the tutorial class. Surely it is desirable to confine university participation in adult education to the supervision of small groups prepared to devote themselves to one topic for at least one year: discussing, arguing, writing about the fundamental unresolved problems of men and Nature; or seeking personal emancipation in a genuine scholarly understanding of some aspect of literature or the arts; or finding a deep satisfaction in doing some craftsman's work really well.

THE BRITISH MUSEUM ARCHAEOPTERYX

Archaeopteryx Lithographica

A Study based upon the British Museum Specimen.
By Sir Gavin de Beer. Pp. xi+68+16 plates.
London: British Museum (Natural History), 1954.)
10s.

THE specimen of *Archaeopteryx*, 'the first bird', is certainly the best known fossil in the British Museum (Natural History), and it is proper that it should be examined as completely as is now possible, and lavishly published. Thus Sir Gavin de Beer's monograph is very welcome. In it he gives a detailed account of its discovery and purchase from Dr. Haberlein, the family doctor of Pappenheim, who received it in payment for medical services to the quarrymen. He gives also the facts, pungently published by John Ruskin in 1864, of the payment of the price—£700—in two instalments, the second guaranteed by Richard Owen, since the Museum Trustees were not in a position to do so. The sum paid formed the dowry of Haberlein's daughter.

The specimen so acquired was immediately described by Owen (1863). Then John Evans (later Lord Lubbock) discovered on the slab a jaw bone with teeth, and a brain cast, and it at once appeared in all general works dealing with geology and evolution. Later it has been the subject of very many papers. But only when a Serbian philosopher, B. Petronievics, examined it during the First World War was it actually prepared by Mr. F. O. Barlow, who exposed the shoulder girdle and pelvis, described by Petronievics in association with A. Smith Woodward. Petronievics returned to the work, and further preparation by Barlow and L. E. Parsons exposed much of the vertebral column and other elements of the girdles.

The next important contribution to our knowledge of its structure was the recognition by Dr. Tilly Edinger that Evans's brain cast was actually such, and that the brain it represented was of the type found in modern reptiles, and lacked the qualities characteristic of modern birds. Meanwhile, a second skeleton in Berlin was described by Dames and, as it has a good skull, was widely discussed. At first regarded as belonging to the same species as the

London specimen, it later came to be considered as a member of a different species, then genus, and finally family!

During recent years Mr. Parsons has carried out further preparation; the slab has been examined by X-rays, and examined under ultra-violet light by K. Lambrecht in 1928. Sir Gavin de Beer, photographing the specimen by its own fluorescence under ultra-violet light, has made out new structures, especially the long-sought sternum. He confirms Dr. Edlinger's account of the brain cast and finds a continuous series of twenty vertebrae in front of the tail, and two displaced cervicals. He finds, too, many abdominal ribs, as in the Berlin specimen. But the most important discovery is of a sternum, a thin sheet of very spongy bone, transversely widened, very short along the bird's length, and appropriate to the short flattened coracoids, which presumably articulate with it. Little can be added to what is at present known about the limb skeleton; but Sir Gavin agrees with Lambrecht in holding that the skeleton was not pneumatic. The feathers of the wings have always been recognized as singularly resembling those of modern birds, and Steiner endeavoured to show that *Archaeopteryx* lacked a fifth secondary and was 'aquinto-cubital'. Sir Gavin shows that the feather impressions were made by the under-surface, and that sometimes a single feather made two impressions. His detailed discussion, based not only on direct visual observation but also on large photographs made with glancing illumination in four azimuths, is convincing. It shows that Steiner was wrong, and that the flight feathers are identical with those of modern flying-birds.

Sir Gavin compares the two specimens of *Archaeopteryx* and concludes, without certainty, that they may well belong to the same species. He then goes on to consider the affinities of the bird, holding that a derivation from some reptile of the general nature of *Euparkeria* is reasonable, in agreement with Robert Broom. Then he goes on to discuss the origin of flight, rejecting the 'pro-avis' theory of Steiner, the cursorial pro-avis of Nopsca, Beebe's tetrapteryx theory, and returning to the classical arboreal origin.

The whole work is most useful, it establishes definitely many previously doubtful structural features, and discusses many problems on a reliable basis of fact, and with a well-controlled imagination. The work is illustrated by fifteen large photographic plates, some taken by ordinary, often glancing light, others by phosphorescence under ultra-violet illumination. They establish the facts well enough; but it still seems to be difficult to take such good photographs, and to have such good blocks made from them, as the French museums regularly do.

D. M. S. WATSON

GENESIS OF MODERN SCIENCE

The Scientific Revolution 1500-1800

The Formation of the Modern Scientific Attitude.
By Dr. A. R. Hall. Pp. xvii+390. (London:
Longmans, Green and Co., Ltd., 1954.) 21s. net.

THE inauguration in Great Britain of the systematic study of the history and philosophy of science has prompted the publication of a number of works which have implicitly, or in some cases explicitly, aimed at particular readjustments in historical and sociological perspective. Few historians

would now be so bold, or so purblind, as to ignore the existence of scientific activity before the Ionian Greeks; to write off the millennium of the Middle Ages as one of unparalleled gloom and sterility; or to ignore the economic motives or implications of discovery. But the time was ripe for a candid reassessment of the whole problem of the genesis of science as we know it to-day. This task has, in my opinion, been admirably achieved by Dr. A. R. Hall in this book.

After sketching the state of scientific knowledge at about the year 1500, as it was portrayed in the widely esteemed "*Margarita Philosophica*", Dr. Hall considers the tentative groupings, marked by many false starts, which characterized the sixteenth century. Here what was radical innovation in such outstanding men as Vesalius and Tycho Brahe is clearly distinguished from the indications of mental inertia which characterized even the most active minds. Then follows a discussion of the attack on tradition in astronomy, mechanics and biology. Galileo's part in this is presented as truthfully as is possible within the space available, and, what is less often done, Descartes's relative failure is shown to have been due, as Prof. N. Kemp Smith has recently emphasized, to his lack of interest in applied mathematics. The comparison is taken up again in the chapter on the principles of science in the early seventeenth century, where the invaluable role of Descartes as 'publicist' of the new mechanical approach to the deductive grounding of natural philosophy (in the widest sense of that term) is well brought out. The technical aspects are dealt with in a separate chapter, where the relation between specialized craft and theoretical advance is neatly expressed in the words: "Common craftsmen held a considerable reservoir of ingenuity, when scientific imagination arrived to draw upon it". A very good account is given of the Principate of Newton in which that great man's achievement is clearly related to that of his contemporaries. But although the author mentions that Newton "gave to science formal concepts of space and time", he does not indicate the light which Newton's naïve (though within its context highly effective) enunciation of these concepts casts on the whole question of the nature of scientific thought.

In the far-ranging and stimulating account of descriptive biology and systematics there is a slip in terminology: Cesalpino could scarcely have made much progress by taking the seed as a basis of classification; it was, of course, the fruit. Incidentally, it is necessary to point out that Linnaeus's use of the number of 'styles' as the *differentia* within the classes must be interpreted as the number of free female organs, otherwise the class Hexandria Monogynia (p. 294) could scarcely be described as having "styles 0". The chapter on the origins of chemistry includes an estimate of Boyle as "essentially a physicist looking at chemistry", which though cogently argued is unlikely to gain general assent. Neither is it quite fair to Mayow to say that Hales "invented" the technique of collecting gases over water, nor to Scheele to call him a "German apothecary", even though it is true that Stralsund was incorporated into German territory. The book concludes with a review of physics in the eighteenth century. Valuable appendixes on botanical illustration and rival planetary theories are added, together with excellent bibliographical aids and a not quite so excellent index—here a little expansion would have been helpful.

In the recently published "Dialogues" nothing is more striking than Whitehead's insistence on the complete dissolution of the conceptual framework of physics during his lifetime. This suggests the only major criticism of Dr. Hall's book—or rather of his title—namely, that for one reader at least it has provided yet another admirable document in support of the view that no single revolution has ever taken place. Not only (as the title indicates) is the time-lapse too great, but also, to the extent that crises were recognizable, they took place at widely different times in different departments of science. We are now in the middle of the third in the fundamental science of physics. Dr. Hall makes no claim that he has said the last word on the subject. What a reviewer may claim is that in providing an admirably constructed and most attractively presented scheme on which subsequent research may be based, he has done something far more valuable. Printer and publisher are also to be congratulated on a production of such quality, and at a price which should enable everyone interested in science and civilization to read and re-read it.

WILLIAM P. D. WIGHTMAN

MODERN PHYSICAL METALLURGY

Progress in Metal Physics

Edited by Dr. Bruce Chalmers and R. King. (Progress Series.) Vol. 5. Pp. vii + 324 + 36 plates. (London Pergamon Press, Ltd., 1954.) 60s. net.

BY far the longest of the five reviews comprising this fifth volume in the series is the report on precipitation, by H. K. Hardy and T. J. Heal. This is not surprising, for more than a thousand paper relating to precipitation have been published, and reference is here made to no less than three hundred and fifty of them. The report affords an excellent illustration of the advantages which accrue when the authors of critical reviews are themselves active in the field under discussion. The treatment is comprehensive and systematic, from both theoretical and experimental points of view. It shows, on one hand, how much has been achieved and yet, on the other, how little is really known about this subject. A critical assessment of knowledge on the precipitation process for a number of alloy systems leads to the conclusion that only for the aluminium-copper system can a qualitative account of the ageing process at all degrees of super-saturation be given with some degree of certainty.

From time to time urgent technological problems profoundly influence the direction taken by fundamental research by focusing attention upon basic phenomena about which little is known. In this way the catastrophic brittle failure of mild-steel ship plates has led to a greatly increased interest in the general problem of fracture, and research to minimize such failures by control of metallurgical factors has been accompanied by widespread effort to elucidate the mechanism of fracture in general. Both aspects are adequately dealt with in an interesting and readable review by N. J. Petch on the fracture of metals.

Experimental observations of slip and twinning in metal crystals are of vital importance to the proper understanding of plastic deformation. Generalizations may be made about the simpler features, but a greater detail is revealed the picture becomes one of increasing complexity. This is clearly illustrated by

the review on geometrical aspects of the plastic deformation of metal single crystals, in which R. Maddin and N. K. Chen have summarized the experimental evidence according to the crystal structure of the metal concerned.

The review on the structure of liquid metals, by B. R. T. Frost, is particularly timely because of the interest now being shown in the subject. Both indirect and direct methods of obtaining information about the arrangement of atoms in liquid metals are reviewed in an interesting and comprehensive manner. By contrast, the solidification of metals, by Ursula M. Martens, is more restricted in its scope. It is mainly concerned with the work of the Toronto school and is limited to the solidification of a single phase and in particular to what happens after the crystal nucleus has been formed. A less general title would have been more appropriate for this review.

By and large, however, this is a useful volume that will bear comparison with the best of the earlier ones in the series. It will be used by many metallurgists who would not regard themselves as metal physicists, and it is therefore unfortunate that in their preface the editors stress the idea that there is now a "... distinct study of Metal Physics". In any technology satisfactory development and progress depend upon the continuous assimilation of new knowledge. Metallurgy as we know it to-day exists because knowledge and ideas which at one time seemed far ahead of and remote from practical considerations have been assimilated into 'classical' metallurgy. This process must go on, and nothing should be done that may prevent or delay new discoveries and conceptions in the science of metals from being absorbed into the technology of metallurgy.

A. G. QUARRELL

A GEOCHEMICAL CLASSIC

Geochemistry

By the late Prof. V. M. Goldschmidt. (International Series of Monographs on Physics.) Pp. xi+730. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 63s. net.

CLARKE'S celebrated "Data of Geochemistry"—still the leading best-seller of the United States Geological Survey—represents the culmination of the first long pioneering stage of geochemistry, a period that was characterized by the accumulation of the outstanding facts on a macro scale. Similarly, this great work by V. M. Goldschmidt is already the unrivalled classic of the second stage of the subject, which was characterized by the discovery of the relations between ionic radii and the distribution and associations of elements, and by the successful application of X-ray and optical spectrography to the many problems associated with 'trace elements'. In these and related fields Goldschmidt was the acknowledged leader. His book is brightly illumined by the high-lights of his own achievements and inspirations, and may be confidently hailed as one of those rare contributions to scientific literature which long remain a delight to read and a potent stimulant to further research. This assessment is unaffected by the fact that geochemistry has already passed its second climax and has entered the third stage of its development, with isotopic investigations now well established in the van of progress. For this

reason the book is unavoidably out of date in some respects, certain chapters having been left unfinished at the time of Goldschmidt's lamented death in 1947. But access to recent work presents no difficulties, whereas for access to the mature thoughts of geochemistry's greatest genius there is no alternative to this inimitable book, in which, moreover, the hitherto unpublished results of Goldschmidt's latest work have been incorporated.

The work of editing and filling in the gaps has been skilfully carried out by Dr. Alex Muir, with the assistance of a number of devoted friends, whose translations and other contributions are fully acknowledged in a preliminary note. At his discretion, and always within square brackets, the editor has here and there added comments on recent advances and references thereto. Most of the gaps were in the first of the two parts into which the book is divided. Part 1 consists of six chapters (one hundred and twenty-five pages) dealing with the scope and development of the subject; the distribution of elements during the evolution of the earth and the crystallization of magmas; the fundamental data required in the quantitative treatment of geochemical processes, in the cosmos as well as in the earth and its various 'spheres'; and finally with the principles of crystal chemistry, this being the part of the subject with which Goldschmidt's name is most intimately associated.

Part 2 deals in fifty-seven sections (nearly six hundred pages) with the abundances, crystal chemistry and distribution of the elements in minerals, ores, rocks, soils, organisms, waters and atmosphere; with their natural circulations; and with relevant data for meteorites and various parts of the cosmos. This bald statement, however, fails to give any idea of the liveliness and exciting quality of these fascinating pages, or of the variety of topics that come under discussion. Under beryllium we learn the reasons for the colour and rarity of emerald. Granitization is discussed under sodium. Silicon introduces the origin of flint and its curious properties, the recognition of which by the craftsmen of the Stone Age laid "the material foundations of modern civilisation". Nitrogen raises the intractable geochemical problems of the Chilean nitrate deposits; Goldschmidt meets the challenge by proposing promising new lines of investigation. It is well known that in 1922 Goldschmidt inferred from geochemical principles the existence of a sulphide-oxide layer between the core and the silicate mantle of the earth. Although current geophysical evidence fails to support this view, as Goldschmidt fully realized, seismologists will be interested to know that he had never wavered in his faith that there must be such a level in the deep interior (p. 523, under sulphur). So one could go on indefinitely. The book has something of value, not only for geologists and mineralogists, but also for scientific workers of every kind from oceanographers and soil chemists to crystallographers and astrophysicists. Moreover, the human significance of geochemistry is not forgotten. Practical applications to mining, metallurgy, chemical industry and agriculture are plentifully scattered through this most generously endowed book.

There will be widespread gratitude to Dr. Muir and his band of helpers for making possible the posthumous publication of this noble work, and to the publishers for a production of which Goldschmidt himself would have felt justly proud.

ARTHUR HOLMES

The Sources of Eddington's Philosophy

By Prof. Herbert Dingle. (Eighth Arthur Stanley Eddington Memorial Lecture, 2 November 1954.) Pp. vi+64. (Cambridge: At the University Press, 1954.) 3s. 6d. net.

THE annual Eddington Memorial Lecture is expected to discuss some topic which would have interested Eddington. It is not necessarily expected to discuss Eddington himself, and it is conceivable that the two tasks are mutually incompatible. Nevertheless, recollecting the antithesis to Eddington which Prof. Herbert Dingle maintained in the former's life-time, it is important to-day to read the considered judgment of ten years later. The old instinctive antagonism is there, the empiricist's mistrust of the purely rational share in scientific reasoning, a share which undoubtedly Eddington did over-emphasize. Dingle himself is not always to be acquitted of over-emphasis; for example, on p. 31: "I do not think that anyone but Eddington would have had the amazing combination of courage, perverted outlook and persuasive skill necessary to advance such an utterly fantastic notion".

What is novel and important in this lecture is a reclassification of some subjective and objective aspects of the internal and external worlds, which the author claims to draw from his critique of Eddington, but which, at least in shrewd and clear manner of statement, has here an originality of its own. It would be good to see in a future publication a *de novo* statement of Dingle's own situation concerning subjective elements in knowledge, without it being loaded by his disagreements with Eddington which tend to veil the development of genuinely original ideas.

But to read 'Dingle on Eddington' must always arouse a frustrated wish to have also an Eddington on Dingle; the great pioneer might possibly speak of his critic as in the latter's final words of this lecture: "He did not know what he was doing, but I believe that what he did was supremely great".

MARTIN JOHNSON

Probleme und Beispiele Biologischer Regelung

Von Prof. R. Wagner. Pp. viii+219. (Stuttgart: Georg Thieme Verlag, 1954.) 29.40 D. marks.

THIS book, the author of which is professor of physiology in Munich, is a discussion of biological processes from the point of view of servo-theory. Being a biologist himself, Prof. R. Wagner is fully aware of the fact that a major theme of physiology from the times of Claude Bernard and Ludwig up to the present day has been to discover and study biological self-regulations. The results of this work are readily available for those who want to rewrite the classical findings in terms of servo-theory.

Such pursuit in itself is an amusing intellectual exercise, and in this respect Wagner's book will not be found wanting. Criticism can only be levelled against its treatment of reflex self-regulations of the muscle contraction, a field in which so much new material has come to light within the past years that Wagner's discussion is obsolete. The author does not recognize antidromic regulations as a likely possibility. Yet most nervous centres are provided with recurrent collaterals, and the antidromic feedback of the ventral horn cells is quite well understood. While in view of the general aims of the book this is not a serious criticism, it does, however, serve

to emphasize the challenge of the experimenter, which is: What has servo-theory to offer as an aid to him in his work? Its mode of approach has now been presented many times to the biological world, propagandistically, but also unostentatiously, as in Wagner's book.

Would it be unfair to say that as a short-cut to experimental ingenuity servo-theory has not yet proved to be of much value compared with the resources of sound biological imagination? For the reply to this question the reader will have to turn to Wagner's work and judge for himself. Its author is a competent enough guide in both physiology and servo-theory.

British Pharmaceutical Codex, 1954

Pp. xxxii+1340. (Published by direction of the Council of the Pharmaceutical Society of Great Britain.) (London: The Pharmaceutical Press, 1954.) 63s.

THE first edition of the "British Pharmaceutical Codex" was produced by the Pharmaceutical Society in 1907; the fifth revision has now appeared after an interval of only five years and is thinner than its predecessor. This book differs from the "Pharmacopoeia" by being less exclusive, so that it gives information about a wider range of drugs the status of which is in doubt, and by the inclusion of information about the actions and uses of drugs.

The new edition contains two hundred pages fewer than its immediate predecessor, and this change has been achieved by deleting many of the less reputable drugs, some of which are still used. The "Codex" is becoming a guide to the drugs which ought to be used and is losing its value as a guide to all the drugs which actually are used. If it continues to develop in this direction, the time may come when it will be fused with the "Pharmacopoeia", and a new book will be started to provide official information, of a less ambitious kind, about all the drugs which are actually in use. In the meantime, the "Extra Pharmacopoeia" provides a useful summary of unofficial views about unofficial drugs.

The Revision Committee is to be congratulated on the way it has performed a prodigious task in a short time. The new book contains a great amount of reliable information about recent advances in therapeutics and will be invaluable to all concerned with the practical art of curing the sick.

J. H. GADDUM

A Short History of Wool and its Manufacture (Mainly in England)

By E. Lipson. Pp. vii+205. (London: William Heinemann, Ltd., 1953.) 12s. 6d. net.

MOST of this book was published by the author thirty-three years ago as "The History of the Woollen and Worsted Industries" (London, 1921). In writing the present volume, he might have advanced our knowledge of the subject in two ways: by adding a satisfactory account of the wool trade and industry's progress during and since the nineteenth century; and by revising and extending his account of earlier periods in the light of work published by other scholars since 1921. As it is, the chapter on the nineteenth and twentieth centuries is sketchy and slight: the usual account of basic technological developments to about 1850; their effects upon hand workers (but why illustrate the condition of hand-loom weavers by material relating

to Bolton cotton weavers?); and then a wild leap into the present century and a potted version of the Wool Working Party Report. For earlier periods, Mr. Lipson takes little account of material published since 1921 about wool textile history. Readers are directed to the bibliography of his 1921 publication, and there are no footnote references. The labours of more recent scholars have been in vain. The "Economic History Review" might never have been printed. To give one example, in spite of Prof. Carus-Wilson's account of an "industrial revolution" in the thirteenth-century woollen industry, written largely as a corrective to Mr. Lipson's earlier view of the period, we still find Edward III "reviving" this "decaying" industry.

The two new chapters on wool—English, merino and cross-bred—are interesting. The style of the book is easy to read; but for the serious student this pleasure is marred by the practice of quoting evidence without indicating its origin, or often even its date and author.

E. M. SIGSWORTH

Man Meets Dog

By Konrad Z. Lorenz. (Translated by Marjorie Kerr Wilson.) Pp. x+199. (London: Methuen and Co., Ltd., 1954.) 15s. net.

THE ability to write clearly and simply is not always coupled with high scientific attainments; when it is, books to remember result. We recall "King Solomon's Ring", a study of the animal mind, by Dr. Konrad Lorenz. The author now follows it with a volume on the dog, plus the cat, in the same lucid, humorous and unassuming style as its predecessor. He writes of the origin and domestication of the dog, its character, traits and conduct, in a variety of circumstances, including "the inviolable laws governing canine ceremonial, which determine the behaviour of stronger and weaker, of dogs and bitches". The cat, he says, is but a recent recruit and not really domesticated—that is, relatively to the dog, which may have been attached to mankind for 20,000–50,000 or 60,000 years. A word must be spared for the numerous and amusing drawings by the author and Annie Eisenmenges that adorn the pages. "Dog Meets Man" will bring enlightenment combined with pleasure to many readers.

FRANCES PITT

Four-Place Tables of Transcendental Functions

By Prof. W. Flügge. Pp. ii+136. (London: Pergamon Press, Ltd.; New York: McGraw-Hill Book Company, Inc., 1954.) 25s. net.

THIS book is mainly concerned with the tabulation of so-called 'non-elementary' functions, many of which were until comparatively recently the esoteric property of pure mathematicians and computers. To many engineers and physicists, they were little more than names, to be seen perhaps in the indexes of more advanced text-books and treatises on mathematical physics, and the few that came face to face with them in their problems were more often than not at a serious disadvantage owing to the extreme scarcity of numerical information concerning their values.

Modern technological developments, involving as they often do considerable incursions into 'non-elementary' mathematics, have created an essential and urgent need for tables of the functions involved, at any rate to what the author describes as slide-rule accuracy. Thus this book, to quote the preface, is intended to meet such requirements and "should be

kept close to the slide-rule, in the middle drawer of the desk and not on the shelf".

Each section is prefaced by an adequate collection of relevant formulae and bibliographical references to more elaborate and more accurate tables that might be required. Elementary functions are by no means ignored, and in the first two sections are to be found tables of trigonometrical functions in degrees and radians, hyperbolic and exponential functions and Napierian logarithms. The third and fourth sections contain tables of Bessel functions of both kinds, both simple and modified, and the ber, bei, ker and kei functions of Kelvin; the fifth deals with elliptic integrals of the first and second kinds and with all degrees of incompleteness. Finally, a miscellaneous section supplies tables of the error function, the gamma function, and the sine, cosine and exponential integrals.

J. H. PEARCE

Blood Groups in Man

By Dr. R. R. Race and Dr. Ruth Sanger. Second edition. Pp. xvi+400. (Oxford: Blackwell Scientific Publications, 1954.) 30s. net.

IT is four years since the first edition of Race and Sanger's book was published. In the intervening period an additional blood-group has been described (the Kidd-group), and the pace at which blood-group research is being prosecuted continues unabated.

This new edition is valuable, therefore, since it comprehensively reviews and describes the whole field of human blood-groups and brings us right up to date. There is, for example, an additional chapter on blood-groups and linkage; all this has made the volume bigger than the previous one. This new edition is superior to its predecessor, since it is better balanced and is written with a considerably more critical eye.

In spite of the wealth of information it contains, it is pleasant and easy to read.

This book has now become an established favourite and a standard work on the subject.

F. STRATTON

Biology of Deserts

The Proceedings of a Symposium on the Biology of Hot and Cold Deserts, organized by the Institute of Biology. Edited by J. L. Cloudsley-Thompson. Pp. iv+224. (London: Institute of Biology, 1954.) 14s.

THE papers read at the Conference on the Biology and Productivity of Hot and Cold Deserts which was organized by the Institute of Biology during September 1952 have now been published in one volume. The book is one of compelling interest not only for the skill in which its subject-matter has been chosen but also for the clear and lucid style of the many contributors. The papers themselves are grouped under the headings of climate and physical environment, plant ecology, entomology and ecology, economics and mammalian physiology and ecology; they include such varied topics as the microbiological formation of sulphur in Cyrenaican lakes, origin and development of insect plant pests in the oases of the French Sahara, and, somewhat surprisingly, the influence of climatic factors on the reaction of desert shrubs to grazing by sheep. Besides the papers, the book contains reports of the ensuing discussions; these again are gems of clarity and compression and add to the merits of a volume which should find many readers in biological and other circles. The editor may feel well pleased with his efforts.

CHEMICAL INDUSTRY AND AIR AND WATER POLLUTION

A SYMPOSIUM on "The Prevention of Atmospheric and Water Pollution in the Chemical Industry", organized by the London Section of the Society of Chemical Industry, was held at the Senate House, University of London, during April 4-5. A small exhibition in connexion with the symposium was arranged in the Department of Chemical Engineering, University College, London.

In a general introduction to that part of the symposium dealing with liquid wastes, Dr. B. A. Southgate, director of water pollution research, Department of Scientific and Industrial Research, discussed the possibilities of predicting the effects on a stream of discharging to it known quantities of an effluent which, by laboratory tests, had been found to conform to given standards of quality. From the results of tests for toxicity, it should be possible to predict with some confidence the direct effect of an effluent on a fishery. There would be much more uncertainty in predicting the effect of a liquor on the concentration of dissolved oxygen in a stream, since neither the rate at which oxygen would be dissolved from the air, nor the rate at which organic matter and ammonia would be oxidized by bacterial action, is known with any degree of accuracy.

After papers by Mr. J. A. Evans (Federation of British Industries) on the legal aspects of pollution and by Dr. S. H. Jenkins (Birmingham, Tame and Rea District Drainage Board) on the discharge of trade effluents to sewage purification works, the morning session closed with an important contribution by Dr. D. H. Sharp and Mr. A. E. Lambden, of Fisons Pest Control, Ltd., on the treatment of the waste waters from a factory making insecticides and fungicides and discharging its treated effluent to the Granta above Cambridge. The effluent—some fifty thousand gallons a day—before treatment contains dinitro-*ortho*-cresol, phenols, glycollic acid, secondary amines and copper, and is strongly coloured. It was known that organic nitro-compounds cannot readily be destroyed by bacterial action; this was found to be so, for example, during the War, when methods were sought for disposing of liquors containing picric acid and dinitrophenol from shell-filling factories.

The method of treatment adopted by the firm is to pass the liquor, under acid conditions, through beds of activated charcoal, where most of the dinitro-*ortho*-cresol and phenols, and part of the glycollic acid and amines, are adsorbed. Copper is then removed by adding lime; a precipitate, mainly of calcium sulphate and phosphate, separates, and this on settling carries down the copper with it. The well-known method of displacing copper from solution by treatment with metallic iron was not adopted because of the lengthy period of contact, and thus the large plant, required. After dilution with river water, final effluent and the factory sewage, the liquid is passed through percolating filters, where the concentrations of the remaining phenols and glycollic acid are reduced by 90 per cent and 80 per cent, respectively; finally, the liquid is aerated in a tank, passed through a sedimentation tank, and discharged. Taking into account the apparent intractability of the original liquor, the effluent is of very good quality. The cost, however,

was given as £1 per 1,000 gallons—an example of the great expense to which a manufacturer may be put if he has to treat a difficult waste water to yield an effluent of sufficiently high quality for discharge to a small stream.

Dr. W. H. Blackburn (Joint Research Committee of the Gas Council and the University of Leeds) discussed the problem of disposing of liquors from gasworks—about 1,300 million gallons of these liquors are produced annually in the United Kingdom. The general line of attack is to make such changes in the methods of purifying gas at a gasworks as will facilitate the subsequent treatment of the liquor, and then to discharge this liquor, wherever possible, to a domestic sewer for treatment in admixture with sewage at a sewage works. Thus, the concentration of thiocyanate in gas liquor can be kept low by restricting oxidation of ammonium sulphide to polysulphide (which reacts with cyanide to give thiocyanate) and various measures—including removal of tar from the hot gas by electrostatic precipitation—can similarly be taken to reduce the concentration of polyhydric phenols and other complex acidic substances which are difficult to destroy by bacterial action. Treatment of gas liquor by itself is at present very expensive—the cost at a plant at the Tingley works of the North Eastern Gas Board, for example, is £2 10s. per 1,000 gallons.

In a paper on waste waters containing cyanides, Mr. A. E. J. Pettet and Dr. G. C. Ware, of the Water Pollution Research Laboratory, Department of Scientific and Industrial Research, described the two most frequently used chemical methods of treatment, namely, precipitation of insoluble complexes with iron and the more efficient process of oxidation by chlorine to cyanogen chloride, which then hydrolyses to cyanate. Both these methods are used on a large scale, but they require accurate control and are somewhat expensive to operate; there is thus much interest in the recent discovery that relatively high concentrations of simple cyanides, and of some complex ones, can be destroyed by biological filtration. The organism responsible, which appears to be an Actinomycete, converts cyanide almost quantitatively to ammonia, which in a percolating filter is then oxidized by other organisms to nitrite and nitrate.

In the paper and board industry (Mr. R. D. Isabell, British Paper and Board Industry Research Association) and the sugar beet industry (Mr. O. H. Phipps, British Sugar Corporation, Ltd.) the problems of disposing of effluent are somewhat similar in that, in both, success depends on reducing so far as possible the discharge of oxidizable matter with the waste waters. In paper mills, where raw material such as esparto is digested with caustic soda, something like half the weight of organic matter in the raw material is dissolved. The lye is then separated from the pulp, concentrated in vacuum evaporators, and burned to yield sodium carbonate, which, after causticization with lime, is re-used in the process. An important problem, therefore, is to separate the liquor from the pulp, and so wash the pulp free from adhering liquor, while using as little water as possible so that the whole of the liquor and washings can be evaporated

economically for soda recovery. The industry's research association is working to improve the efficiency of the washing process; but in many mills the design of the digestors is such that an efficient closed counter-current system of washing cannot be employed.

In the sugar beet industry, if all the waste waters were discharged, extremely large and costly plant would be required to treat them. In theory, the volume of effluent can be reduced by about 98 per cent by re-using the three types of waste water—process water, transport water and condenser water—in separate circuits in the factory. Mr. Phipps reported that at many beet-sugar factories in Britain the volume of liquid discharged for treatment now closely approaches this minimum. This residual liquid is stored in lagoons, where it undergoes some purification by biological action, and can finally be treated in percolating filters to yield an effluent of quite good quality. Re-use of what were previously waste-waters in the factory has given rise to some difficulties—for example, corrosion has been increased—but these are being overcome, and it is evident that the problem of disposing of the effluent from the beet sugar industry, which at one time appeared to be so intractable, is well on its way to solution.

Proceedings on the second day related to the abatement of air pollution by the chemical and allied industries, and were opened by Sir Hugh Beaver, who referred to the need for measures to be taken to give a cleaner air, and compared and contrasted the position as he saw it in the United States and in the United Kingdom.

W. A. Damon (chief alkali inspector, Ministry of Housing and Local Government) dealt with the operation of the Alkali Act, mentioning that it is usually the treatment of large volumes of gas containing a relatively low concentration of a noxious constituent that poses the greatest problems. After referring to the washing of power-station gases and the factors governing dispersal of chimney emissions, he went on to deal with the specific cases of emissions from petroleum refineries, blast furnaces, Bessemer converters, open-hearth furnaces, coke ovens and gasworks, clay firing, lime burning and the extremely difficult problem of fluorine emissions from the aluminium, clay and steel industries. He stressed that many of these problems will be resolved by time and patience, and that panic measures should be avoided. Industry should realize that there will be an insistent demand for the abatement of pollution and that some of the remedial measures must be a charge on the process.

The zinc industry made its major contribution to a purer air some thirty years ago when roaster gases were diverted from direct emission to air to conversion to sulphuric acid by the contact process. E. Wallis (Imperial Smelting Corporation, Ltd.) described the efforts made in recent years by the industry to increase production on existing plant without increase in air pollution. These related to improved collection of dust from the sintering machines by application of a Venturi-type scrubber, and to reduction in the acidity of the waste gases from the contact acid plants by scrubbing with ammonia, with production of ammonium sulphate as a by-product.

Emissions from superphosphate works were dealt with by K. A. Sherwin (Fisons, Ltd.). After dis-

cussing the emissions from the chamber or contact acid plants, now an essential part of any large fertilizer works, he went on to deal in some detail with the treatment of the silicon fluoride evolved in the production of superphosphate. The acidity of the gases is reduced to a very low figure by washers of conventional design; but the disposal of the liquid effluent of hydrofluosilicic acid mixed with gelatinous silicic acid would be a major problem were not the majority of fertilizer factories necessarily situated on tidal water. The bulk of superphosphate made is now mixed with other fertilizer salts to give various compound fertilizers, most of which are prepared in granular form. Granulation leads to appreciable dust emission, which necessitates the installation of cyclones followed by water-fed scrubbers. Production of triple superphosphate by action of phosphoric acid on phosphate rock gives rise to emission of silicon tetrafluoride, which can be dealt with on routine lines.

Most of the sulphur fed to the viscose process of rayon, etc., manufacture is emitted to air as carbon disulphide and hydrogen sulphide in concentrations at staple fibre factories of 800 and 300 p.p.m., respectively. D. C. F. Pratt and Dr. A. Rutherford (Courtaulds, Ltd.) described the experiments leading up to the construction and the ultimate operation of a large prototype scrubber whereby the hydrogen sulphide content of the waste gases was reduced to 10–20 p.p.m., and the carbon disulphide reduced by 50–70 p.p.m. This was effected by application of the 'Ferrox' process, whereby the contaminated air is scrubbed by an alkaline medium containing a suspension of hydrated ferric oxide, the absorbed sulphide being then converted to sulphur and the iron oxide regenerated by aeration.

A. Jackson and J. M. Solbett (Simon-Carves, Ltd.) dealt with the problem of the tail gases from contact sulphuric acid plants. In the years immediately following the War, the four-stage units burning brimstone were operated with a conversion efficiency of 98 per cent. Since 1950, however, a large programme of construction of pyrites-burning plant has been undertaken, and here, because of the lower oxygen to sulphur dioxide ratio, conversion efficiency is necessarily lower and the acidity of the escaping gases consequently higher. Reduction in acidity can be effected by water washing, in a few cases where there is a demand for the bisulphite produced by scrubbing with alkali, by the basic aluminium sulphate process or the sulphidine type of process using aromatic amines, or more usually by the ammonia process whereby ammonium sulphate is produced as a by-product. A problem at plants burning brimstone, especially when of high bitumen content, is that of acid mist in the final escape, and electrostatic precipitation seems the most practicable remedial technique.

E. Burke, director of research for the Associated Portland Cement Manufacturers, Ltd., referred to the problem of dust arrestment in the expanding cement industry. The difficulties are related to the enormous volume of kiln gases to be treated and the high moisture content, which carries with it the hazards of condensation and corrosion. He reviewed the three possible methods of dust arrestment—high-duty cyclones, electrostatic precipitation and water washing—and described the design of an electrostatic precipitator evolved as a result of long experience to minimize the hazards of condensation, corrosion, etc., and to be operative at high efficiency

for long periods. He then described the technique of isokinetic sampling at various points in the ducting, so as to determine with reasonable accuracy the dust burden of gases.

A major carbon-black industry is a post-war development, and its installation in the United Kingdom where there are no wide open spaces has led to the development of the elaborate technique described by D. L. H. Allan (Philblack, Ltd.). The manufacture is, of course, a deliberate attempt to produce 'soot'. The soot-laden gases from the burning of a petroleum oil fraction under controlled conditions are taken to electrostatic precipitators, which act essentially as agglomerators, rendering the 'black' capable of arrestment by cyclones. Any residual 'black' in the off-gases is then removed by water scrubbing followed by wet electrostatic precipitation or by bag filtration. The off-gases still contain enough hydrogen sulphide to be offensive

and are disposed of by flaring or burning in a special furnace.

C. J. Stairmand and R. M. Kelsey (Imperial Chemical Industries, Ltd., Billingham Division), taking as typical examples of cyclones the Scroll collector, the high-throughput cyclone, the high-efficiency cyclone and the multicyclone, dealt with the uses to which these can be put as arresters of grit and dust and outlined the procedure for predicting their performance. Cyclones can also serve an extremely useful purpose in reducing the load on more expensive and elaborate secondary collectors; for example, the use of high-efficiency cyclones in connexion with electrostatic precipitators is well known.

Discussion of the various papers related mainly to elaboration of miscellaneous points, and it was noticeable that those papers dealing with visible pollution—cement, grit, carbon black—produced the longer discussions.

THE EXPERIMENTAL APPROACH TO THINKING

WHEN the old Persian philosopher Avicenna, a thousand years ago, felt perplexed and unable to follow a syllogism, he would go to the mosque and pray for his understanding to be opened and his difficulties to be smoothed away. If he were with us now, we could scarcely offer him wiser counsel. The charge made by Graham Wallas a quarter of a century ago that when the text-books of psychology pass from the simpler to the more elusive mental processes "they become in almost every case entirely useless" is almost as pertinent to-day. This is not the place to meditate on the possible causes of this sad state of affairs; but we can feel much sympathy with Sir Frederic Bartlett's aim, in his Friday Evening Discourse given at the Royal Institution, London, on March 4, to use the experimental method in the hope of casting a ray of light on the darkness of our thoughts. He would be content if he could demonstrate that problems of human thinking can fruitfully be made a subject for experiment; but he would not wish to imply that an experimental approach to the study of thinking is new. Four years ago, Prof. G. Humphrey, in a scholarly work¹, gave an account of a variety of such studies extending over a period of half a century, from the Würzburg School onwards; and in our laboratory at Manchester we have for some time been pursuing the experimental study of thought.

Sir Frederic takes his point of departure from long experience in the investigation of skill and declares that thinking "is in the order of skilled behaviour" in which symbols of various kinds rather than bodily movements are employed. He cites interesting examples from everyday life in which skill in filling a gap is required, such as, for example, when a page is missing from a book we are reading or when, in tracking a target, we lose it for a time and then pick it up again.

He maintains that his analogy between thought and skill is "the most reasonable suggestion and the one most closely in agreement with evidence of a general character". The suggestion, he believes, is also convenient because of recent advances in our knowledge of skills. He does not, however, tell us why it is the most reasonable suggestion, nor does he indicate the general evidence to which he refers.

Sir Frederic observes that bodily skill begins with some outside signal and is "commonly sustained by a succession of such signals". But is not the characteristic feature of thought that it is essentially a central process, *not* sustained by outside signals? If so, the analogy between skill and thought may perhaps not be as fruitful as appears at first sight.

All his proposed experiments are of a similar type or form. Evidence or information is presented to the subject with gaps in it, and in such a way "that the gaps must be filled up by a sequence of related steps or moves". The problems vary in complexity and in the number of items of information provided. At one extreme, the subject is given, say, the digits 1, 3, . . . 17 and asked to fill in the missing items. At the other extreme, a passage is presented describing results of experiments concerned with the effects of temperature on sensitivity, and the subject has to answer certain questions about the conclusions established by the evidence. As examples of intermediate problems we may take as one case where the subject is given the sets 1 2 3 4 : 2 1 3 4 : 2 1 4 3, and has to continue to change the positions of the numbers until he reaches the final arrangement that seems to be aimed at; another example is where the subject is given sixteen letters of the alphabet set out in random order and has to answer the following questions: If any of these letters is chosen at random, how many questions need I ask in order to discover which it is? What are the questions? Put them in order.

Sir Frederic believes that the underlying experimental pattern is quite general and capable of being applied equally to popular and to scientific systems of thought. He employs the idea of 'directionality' in a sense different both from that of N. R. F. Maier and from the earlier Würzburg idea of 'determining tendency', defining it in terms of "more or less regularly increasing probability of next step". It is not clear, however, how this probability is itself to be measured in the experimental situation. Nor is it clear why Sir Frederic thinks it 'certain' that the storage of information (or memory) does not impose 'directionality' upon it. Do not his own distinguished researches on remembering suggest the contrary?

The belief, which Sir Frederic seems to approve, that thinking is "tied up with the solution of problems" may be seriously questioned. It does not appear to be necessary for Sir Frederic's proposals and it is a pity that he has not criticized it. The cliché—so often met in the American text-books—that "thinking is problem-solving" overlooks the fundamental portion of our thinking which has to do with the detection or identification of problems. The very word 'problem' is hard to pin down to any useful meaning, and in much of our thinking we are groping to find out *what* needs to be done rather than *how* it needs to be done.

Whenever we consider experiments in psychology, we should see them in perspective and recognize that there are other methods just as important. Without in any way diminishing the value of Sir Frederic's suggestions about thought and skill, we have to bear in mind that most illuminating insights into thinking have come from men gifted with an intuitive understanding of their own mental life, from novelists

and poets like Probst and Keats, as well as from men of science and mathematicians like Helmholtz, Poincaré, Graham Wallas and Hadamard. Above all, we are indebted to Freud for a far-reaching conception of thought which is at once biological in character and based on profound clinical observation. The scope of the psychology of thought must cover the developmental sequence of mental growth, pathological thought, as well as comparative studies in different cultures. In these spheres, it is vital to supplement experiment with other methods of inquiry. Sir Frederic's proposed experiments are drawn from his interest in skill. A full programme of experimental inquiry into thinking must be founded upon a deep understanding of the characteristic features of thought during the period of development, of non-conscious thought structures, of the psychopathology of thought and of social and cultural influences on thinking. JOHN COHEN

¹ Humphrey, G., "Thinking: An Introduction to its Experimental Psychology" (Methuen, London, 1951).

A NEW ÆTHER-DRIFT EXPERIMENT

By DR. L. ESSEN

Electricity Division, National Physical Laboratory, Teddington, Middlesex

THE special theory of relativity is so well established by indirect evidence that the significance of the original æther-drift experiments has decreased, and the experimental discrepancies in the results obtained have caused few misgivings. Such discrepancies should, however, be examined if further developments in experimental technique enable new and possibly more precise methods to be employed.

The possibility of performing an experiment similar to that of Michelson and Morley but using short radio waves in place of light waves has been discussed in several letters in *Nature*¹⁻⁴, and the experiment outlined in one of these² has now been completed at the National Physical Laboratory.

A cylindrical cavity resonator of length 16.866 cm. and diameter 8.075 cm. was used to control the frequency of an oscillator at approximately 9,200 Mc./s. The resonator was mounted with its axis horizontal and was rotated continuously in a horizontal plane at a rate of about one turn per minute, the frequency of the oscillator being measured by comparison with a quartz standard at intervals of 45° during the rotation.

The theory of the method may be described in the following way in order to bring out the points of similarity to the optical method. The cavity resonates when its length is a whole number of half-wave-lengths and the resonant frequency is given by:

$$f = \frac{v}{\lambda} = \frac{nv}{2l}$$

where v is the phase velocity, λ the wave-length, l the length of the resonator and n the number of half-wave-lengths. In this condition the time taken for the phase of the wave to travel to and fro between the end faces of the resonator is $1/f$. If now because of the earth's orbital motion a relative velocity q be postulated between the resonator walls and the medium of propagation within it, then just as in the optical case, this time becomes:

$$t_1 = \frac{2l}{nv} \left(1 + \frac{q^2}{v^2} \right)$$

when the axis of the resonator is in line with the orbital motion, and:

$$t_2 = \frac{2l}{nv} \left(1 + \frac{1}{2} \frac{q^2}{v^2} \right)$$

when it is at right angles to it. The resonant frequency and therefore the frequency of the controlled oscillator should thus vary by a fractional amount of $q^2/2v^2$ on rotation, there being two minima and two maxima for a complete rotation of 360°.

In the optical experiment, interference fringes are formed between two beams of light which have followed paths at right angles to each other. On rotation of the interferometer through 90°, the positions of the paths are interchanged and the difference in transit time is reversed, giving a fractional change of q^2/c^2 which is observed as a fringe displacement. Another difference from the present experiment is that whereas the phase velocity of the light waves is very nearly equal to the free space value c , it is greater than c for the radio waves and depends on the diameter of the cylinder in which the waves are travelling. The calculated frequency-change is accordingly only 3 parts in 10^9 for the resonator and frequency employed if the earth's orbital velocity is taken as 30 km./s., while the corresponding fractional time-change in the optical method is 1 part in 10^9 .

The results obtained are summarized in Table 1, which gives the average of each set of observations reduced to a convenient form by a correction for linear drift and the subtraction of a constant term. In the last column is given the amplitude of the second harmonic periodic term as determined by harmonic analysis. The figures in the last line are obtained by averaging the observations for every rotation and not by averaging the mean figures given above. The averaging is permissible because the

Table 1. VARIATION OF FREQUENCY WITH ROTATION OF THE CAVITY RESONATOR
Date of measurement, December 3-15, 1954. Unit, 1 c/s. (1.09 parts in 10^{10})

No. of rotations	Deviation of resonator frequency from the reference value at orientation								Amplitude of 2nd harmonic term
	0°	45°	90°	135°	180°	225°	270°	315°	
12	9.1	41.8	59.7	60.9	36.1	0.8	-16.5	-22.2	0.55
7	1.2	22.2	45.6	37.7	18.8	10.0	-6.3	-12.6	2.5
12	2.5	32.3	57.8	43.5	24.2	-6.3	-30.4	-24.9	0.8
22	9.6	18.0	19.6	13.6	9.7	4.6	-5.7	-0.8	1.2
15	6.7	47.2	67.8	49.4	20.4	-31.0	-42.4	-22.4	1.4
22	6.5	33.5	47.8	42.6	9.0	-28.9	-38.5	-27.0	1.6
14	5.8	36.2	52.6	42.0	7.8	-25.0	-40.6	-30.4	0.2
14	-1.6	3.7	4.6	6.8	2.9	-3.0	-6.2	-5.7	0.4
Total 118	0.9	23.3	36.9	29.3	9.4	-15.5	-27.4	-20.9	0.1

Table 2. VARIATION OF FREQUENCY WITH ROTATION OF THE CAVITY RESONATOR, INDIVIDUAL OBSERVATIONS
Unit, 1 c/s. (1.09 parts in 10^{10})

No. of rotation	Deviation of resonator frequency from the reference value at orientation							
	0°	45°	90°	135°	180°	225°	270°	315°
1	-19.0	10.5	17.0	18.5	13.0	6.5	0	-25.5
2	5.5	28.6	11.7	-0.2	4.0	-9.9	-23.8	-11.2
3	5.0	10.5	6.0	1.5	-3.0	-7.5	-12.0	-6.5
4	-19.0	-0.7	13.6	29.8	18.0	8.3	4.5	-27.2
5	5.0	5.0	-5.0	-10.0	-15.0	0	5.0	10.0
6	5.5	4.5	3.5	2.5	-1.5	-9.5	-5.5	3.5
7	-3.0	0.1	3.2	21.3	-0.6	-7.4	-4.3	-1.2
8	-1.0	-3.5	4.0	-4.5	-6.0	-3.5	-1.0	-3.5
9	-10.0	-10.0	-5.0	0	10.0	15.0	5.0	0
10	-5.0	-8.1	3.8	0.7	7.6	4.4	1.3	-1.8
11	-1.0	7.1	5.2	8.3	11.4	-0.4	-12.3	-14.2
12	-5.0	5.6	11.2	11.8	17.1	-6.8	-20.2	-15.6
13	18.0	-0.1	-16.2	3.7	0.5	-7.6	-10.8	-1.1
14	2.0	8.9	10.8	12.7	-15.5	-23.6	-11.8	12.0
Average	-1.6	3.7	4.6	6.8	2.9	-3.0	-6.2	-5.7

observations were all made at about the same time of day. It will be noticed that there is a much larger periodic variation, having one maximum and one minimum per rotation. This was found to be due to a tilt of the turntable and was difficult to remove for reasons explained later. It was least in the last set of measurements, and the individual observations for this set (again corrected for linear drift) are given in Table 2 to illustrate the precision of measurement achieved.

The experiment was performed with existing apparatus and was completed within a few weeks of its assembly. Some of the practical difficulties that were met could probably have been overcome by the construction of special equipment, but others were of a more fundamental nature.

The cavity resonator was made of invar to secure the low temperature coefficient required in its original application⁵, and preliminary tests were therefore made to determine the effect of magnetostriction on the oscillator frequency. The changes of frequency observed on applying magnetic field-strengths between 1 and 10 gauss suggested that the earth's field would produce a periodic change with rotation of about $\pm 2 \times 10^{-11}$, and this could account for the second harmonic term in the results given in Tables 1 and 2.

The turntable, which was adapted from the base of a fatigue testing machine by Messrs. H. L. Cox and N. B. Owen, carried the whole apparatus, including the resonator, the oscillator control circuits and the frequency standard, weighing altogether approximately 5 cwt. It was mounted on rollers and driven through a reduction gear by an electric motor; and a certain amount of gear vibration and non-uniform acceleration was detected. The effect of the vibration was reduced by mounting the oscillator on sponge rubber, but this accentuated the effect due to a tilt of the turntable to which reference has already been made.

The principal practical difficulty was, however, the adjustment of the oscillator to have the necessary small band-width and stability. Under the conditions accepted for observations, the band-width was such that a single comparison of frequencies in terms of the standard could be made with a precision of ± 1 part in 10^{10} ; but when the apparatus was rotating, this condition was not maintained for very long. If the stability of the oscillator could be increased, it might be worth while repeating the experiment with an improved turntable and with the magnetostriction effect eliminated by screening or by using a cavity resonator of different material.

It may be of interest to recall the most recent optical results. In the precise determination made by Joos⁶, the interference fringes were measured by a microphotometer and it was concluded that there was a null result to ± 0.001 fringe or 0.3 per cent of the expected displacement. Miller⁷, however, who carried out the most extended measurements, was critical of this result and afterwards published a paper in which he persisted in his view that there is a definite effect of about 8 per cent of that anticipated. The present experiment suggests that Miller's conclusions cannot be accepted; the effect, if any, is shown to be not more than one-tenth of that reported by him, which must probably be ascribed to some systematic error⁸.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this paper is published by permission of the Director of the Laboratory.

¹ Littman Furth, H., *Nature*, 173, 80 (1954).

² Essen, L., *Nature*, 173, 734 (1954).

³ Littman Furth, H., *Nature*, 174, 505 (1954).

⁴ Crombie, D. D., *Nature*, 175, 350 (1955).

⁵ Essen, L., *Proc. Inst. Elect. Eng.*, 100, Pt. III, 19 (1953).

⁶ Joos, G., *Ann. der Phys.*, 7, 385 (1930).

⁷ Miller, D. C., *Rev. Mod. Phys.*, 5, 203 (1933).

⁸ Shankland, R. S., McCuskey, S. W., Leone, F. C., and Kertli, G., *Rev. Mod. Phys.* (in the press).

OBITUARIES

The Rev. Pierre Teilhard de Chardin, S.J.

FATHER TEILHARD DE CHARDIN, whose death occurred on April 10 at the age of seventy-four, was noted for his substantial contributions to mammalian palaeontology (with particular reference to Palaeocene and Eocene genera) and for his geological and archaeological studies in the Far East. His scientific career may be said to have started in 1903 in Jersey, where he was studying philosophy, for while there he published a few notes on the mineralogy of the island which appeared in a local journal. Then, after a period of two years at the Collège de la Sainte Famille in Cairo as lecturer in physics and chemistry, he was sent to a Jesuit College at Hastings to pursue theological studies. It was while there that he assisted in the excavations at Piltdown and later found the canine tooth which was presumed to belong to 'Piltdown man' (though he himself took no part in the study of these alleged fossil specimens).

From 1914 onwards, de Chardin published a series of excellent monographs in the *Annales de Paléontologie* on fossil mammals from Tertiary deposits in France and Belgium. These dealt mainly with the Carnivora and Primates, and among the latter he described one of the earliest known anaptomorphids, which in some of its characteristics proved to be (apart from tupaoids) the most generalized and most primitive of all known Primates. He supposed this early Primate to be congeneric with the American type *Omomys*; but Simpson showed later (1940) that it was a distinct form and, in honour of its discoverer, renamed it *Teilhardina*.

In 1922, Teilhard de Chardin was elected president of the Geological Society of France, and in 1923 he went to the Far East, where for a number of years he took part in geological expeditions organized by American universities and the American Museum of Natural History. His work in China was particularly noteworthy for the detailed records which he made of the sequence of Tertiary deposits in that part of the world. As a result of these observations, he was able to establish important stratigraphical correlations between the different regions of China, and between these regions and India and Burma. He also extended his studies of fossil mammals to include the Pliocene Camelidae, Giraffidae and Cervidae of South-east Shansi, Pliocene and Pleistocene rodents from North China, and a collection of Miocene cervids from Shantung. From the sites at Choukoutien where remains of *Pithecanthropus* (= *Sinanthropus*) had been found, he described a number of the associated mammals, and then turned his attention more particularly to a stratigraphic examination of the cave deposits and a study of the lithic industry found in relation to the human remains. The stratigraphy of the deposits posed a difficult problem because of the complicated fissuration of the limestone formations; but Teilhard de Chardin adduced a considerable amount of evidence to show that the fossiliferous strata were older than the loessic formation of China but younger than the uppermost Pliocene beds of Nihowan.

Teilhard de Chardin's palaeontological publications are all characterized by a clarity of style combined with conciseness of description. He also had a facility for designing illustrations which were particularly effective in their simplicity, in the sense that they immediately focused the attention of the reader

on the morphological essentials of the specimens which he described. Almost up to the time of his death, he continued to maintain a very active interest in palaeontology. W. E. LE GROS CLARK

Dr. Julius Podolanski

DR. JULIUS PODOLANSKI, senior lecturer in theoretical physics in the University of Manchester, died suddenly on April 12. He was born in Poland in 1905 and his family moved to Germany while he was an infant. He read physics and mathematics at Leipzig and Jena, obtaining the degree of Dr.Phil. of the latter University. Because of the Nazi attitude towards Jews, he was unemployed for a long time in the 'thirties, but eventually found work as a reader with the publishing firm Akademische Verlagsgesellschaft. One of his tasks was to read a proof of Prof. H. A. Kramers's book on quantum mechanics. He did not confine himself to purely technical corrections but detected some actual mistakes in the treatment of the subject. Kramers was so struck by this criticism that he inquired about such an unusual corrector. The result was that Kramers arranged for Podolanski to join him in Leyden in order to assist in the research work of his Department.

Podolanski went to Leyden in 1939; but after the German invasion of Holland he was forced to leave the coastal area and went to Utrecht, where he lived on a small stipend. He was officially forbidden to go to the University because of his race; but seminars were held at my house in order that Podolanski could attend. As the War went on even this difficult way of life became impossible and he was driven into hiding. For a time he carried forged papers and lived alone in an isolated windmill. After the liberation he became my assistant at the University of Utrecht and rejoined me in Manchester in 1948. Shortly before coming to England, he married a Dutch student, Marietje van Rossem, who had courageously helped him while he was in hiding.

Podolanski's scientific activity was originally centred on the more abstract aspects of the theory of fields. He had a thorough and profound knowledge of the general theory of relativity and of the geometrical disciplines connected with it. However, his interests covered the whole range of physics, and he always found time and energy to discuss the most varied problems with research students and colleagues at the different places where he worked. A great reserve and somewhat exaggerated propensity to self-criticism prevented him from publishing the results of his investigations, and apart from the few papers which he was persuaded to publish, the only testimonials to his unceasing activity are the many acknowledgments of his help and inspiration that appear in the papers of other authors. His work on unified field theory in six dimensions published by the Royal Society is one of the most original contributions to this somewhat abstract subject. It is typical of his versatility that another of his significant contributions is the elaboration of a method for the analysis of cloud-chamber photographs of heavy mesons.

Podolanski was outstanding as a teacher; his devotion to his students was unexampled. In fact, he was incapable of refusing any request for help or guidance even when this help was given at the expense of his own investigations. His interest in people showed itself most strikingly by the way

in which he gave any casual group of research workers a sense of belonging to a lively and friendly community. Passing visitors enjoyed the hospitality which he and his wife were always ready to offer; they left as lasting friends. Everyone who in any way came into contact with him will ever remember his colourful and lovable personality.

L. ROSENFELD

NEWS and VIEWS

Foreign Members of the Royal Society

THE following have been elected foreign members of the Royal Society:

George Washington Corner (Baltimore), distinguished for his work on the endocrine control of gestation and especially on the function of the corpus luteum in mammals;

Werner Heisenberg (Göttingen), distinguished for his basic contributions to quantum theory;

Lise Meitner (Stockholm), distinguished for her fundamental discoveries in radioactivity and nuclear physics;

Otto Renner (Munich), distinguished for his researches in plant physiology and nuclear and cytoplasmic genetics.

Rumford Premium of the American Academy of Arts and Sciences

THE Rumford Medal and Premium for 1955 of the American Academy of Arts and Sciences has been awarded to Prof. James Franck, professor of physical chemistry in the University of Chicago. The award was established in 1796 by Benjamin Thompson, Count Rumford, to be given to "the author of the most important discovery or useful improvement on heat or on light", and was first given in 1839. Prof. Franck was formerly professor of physics and director of the Physical Institute in Göttingen, Germany. In 1925 he shared the Nobel Prize in Physics with Gustav Hertz. He left Germany in 1933 and began a new scientific career in the field of photosynthesis, first at Johns Hopkins University and later at the University of Chicago. Since Rumford stipulated that the Premium be granted for discoveries made and published upon the American continent, it has been specifically awarded to Prof. Franck for his important contributions to photosynthesis, both theoretical and experimental.

Royal Aeronautical Society: Awards

HONORARY fellowship of the Royal Aeronautical Society has been conferred on Dr. Igor I. Sikorsky and on Mr. H. Grinstead. The following awards have been made by the Society: *R. P. Alston Memorial Prize*, G. A. V. Tyson, for contributions on flight testing of marine aircraft; *Edward Busk Memorial Prize*, J. C. Wimpenny, for a paper on the stability and control in aircraft design; *Herbert Akroyd Stuart Memorial Prize*, E. E. Chatterton, for a paper on compound diesel engines for aircraft; *Usborne Memorial Prize*, L. F. Crabtree, for a paper on the compressible laminar boundary layer on a yawed infinite wing; *Orville Wright Prize*, D. B. Spalding and B. S. Tall, for their paper on flame stabilization in high-velocity gas streams and the effect of heat losses at low pressures; *J. E. Hodgson Prize*, jointly to Major G. P. Bulman, for the first Barnwell Memorial Lecture, and J. Smith, for the first Mitchell Memorial Lecture; *Branch Prize*, E. Chambers, for a paper on meteorological services for the Comet; *Royal Aeronautical Society Navigation Prize*, J. F. W. Mercer,

for a paper on a quantitative study of instrument approach. Two awards will be made from the Society's R.38 Memorial Fund: to Lord Ventry, to assist him in the carrying out of experiments and to help in the development of the airship *Bournemouth*; and to W. N. Alcock, to assist him in his further investigations in connexion with airships.

Honorary Associates of the City of Birmingham College of Technology

At a ceremony on April 30, celebrating the diamond jubilee of the City of Birmingham College of Technology, honorary associateship of the College was conferred on the following: Dr. James C. Duff, formerly head of the Department of Chemistry of the College; Sir Leonard Lord, chairman of the British Motor Corporation; Sir Frederick Handley Page, chairman of Handley Page, Ltd.; Mr. A. B. Waring, chairman and managing director of Joseph Lucas, Ltd.; Lieut.-General Sir Ronald Weeks, chairman of Vickers, Ltd.; and Mr. T. Williamson, general secretary of the National Union of General and Municipal Workers.

Bohuslav Brauner (1855-1935)

BOHUSLAV BRAUNER, who was born in Prague one hundred years ago on May 8, 1855, was descended on his mother's side from a family eminent in chemistry and in pharmacy. Accustomed from an early age to speaking English, French, German and Russian at home, he became a remarkable linguist. He was educated at the local university and technical school and, after working with R. W. Bunsen at Heidelberg, he studied under Sir Henry Roscoe at Manchester, being particularly interested in the rare elements. In 1881 he was elected to a Berkeley fellowship at Owens College, Manchester, and began to correspond with D. I. Mendeleeff, whose periodic system of grouping the elements aroused his admiration; the two became lifelong friends. Brauner succeeded in preparing a double fluoride of tetravalent cerium and potassium, which on gentle heating gave off free fluorine—the first time this had been obtained by purely chemical means. He was appointed lecturer in chemistry at the Charles University in Prague in 1883, assistant professor in 1890 and full professor in 1897. He was a voluminous writer, and contributed the section on the rare earths for Mendeleeff's "Principles of Chemistry" and a critical discussion on atomic weights to Abegg's "Handbuch der Anorganischen Chemie". The new base, O = 16.000, long advocated by him, was generally adopted at the Paris Congress in 1900. Brauner was a man of giant frame, commanding voice and sarcastic wit; his interest in various sciences included a special one in astronomy. An honorary D.Sc. of the University of Manchester and an honorary Fellow of the Chemical Society (London), he retired in 1925 after completing forty-three years of teaching, and died of pneumonia on February 15, 1935, in his eightieth year.

B.B.C. Services on Very High Frequencies

For some time past it has been the policy of the British Broadcasting Corporation to inaugurate sound broadcasting services in Britain in the very-high-frequency band of 88-95 Mc./s. (see *Nature*, 173, 248; 1954). In its second report the Television Advisory Committee (1952) recommended the adoption of frequency modulation for such very-high-frequency broadcasting and stated that the B.B.C. was ready to start the construction of the necessary stations for the Home Service. In July last year the Postmaster-General announced that the B.B.C. could proceed with the first stage of its plan, and he approved the installation of the first nine stations, which, it is estimated, will eventually provide a three-programme sound broadcasting service to about 75 per cent of the population in Britain. The purpose of very-high-frequency transmissions is to reinforce the existing medium-wave and long-wave services, reception of which is becoming difficult for many listeners because of the increasing interference from foreign stations and from electrical appliances of various kinds.

The first of the new transmitting stations, using frequency modulation, was brought into service at Wrotham, Kent, some twenty-three miles south-east of London, on May 2. The three programmes are on the following frequencies: the Light Programme, 89.1 Mc./s.; Third Programme, 91.3 Mc./s.; and the Home Service, 93.5 Mc./s. The effective radiated power is 120 kW. in each case, and the transmissions are horizontally polarized. The station will serve the London area and the south-east of England within a range of about fifty miles. The B.B.C. built Wrotham in 1950 as an experimental station with two transmitters to enable the problems of high-power very-high-frequency transmissions and their reception to be studied. The third transmitter, which has more recently been built, carries the Home Service and differs from the two already installed in that it is built as two separate units for operation in parallel, with each unit capable of maintaining the service at reduced power in the event of a fault on the other. For the first few weeks, only one of these transmitter units will be in operation, and the Home Service transmissions will not be at full power; the effect of this is not likely to be noticeable except at extreme range.

William Ramsay Centenary Appeal

In 1952, a hundred years after the birth of Sir William Ramsay, an appeal for £100,000 was launched with the following two objects: to construct additional laboratory accommodation in Ramsay's old Department of Chemistry at University College, London; and to make an addition to the general capital fund of the existing Ramsay Memorial Fellowship Trust in order to restore the number of British Ramsay Fellows to the original figure from which it had fallen owing to the decrease in the value of money. The appeal has been successful, and the Trustees have now issued a report (pp. 23; from University College, London, 1955). The report gives a list, with amounts, of all the subscribers: "The Centenary Appeal was directed chiefly to industry and industry has responded nobly". The division of the money is as follows: to University College, £75,000; to the Ramsay Memorial Fellowship Trust, £19,500; to the Glasgow Fellowship (for which a separate subsidiary appeal was made), £4,200. The new building for the Chemistry Department of

University College was completed in August last year, and it enables the Department to take on about forty more honours students and about twenty-five more research workers. Whereas the Fellowship Trust has in recent years only been able to support one Fellow at a time, the increase in its funds will allow it to support two or, on occasion, three Fellows at a time. The report of the Trustees gives a brief résumé of the history of the Trust since it was first raised in 1916 after Ramsay's death, and lists the names of the 152 Ramsay Fellows to date, with brief notes on their careers.

Libraries in Colleges of Further Education in Britain

A REPORT on "Libraries in Colleges of Further Education", prepared as Publication No. 20 by the Regional Advisory Committee for Librarianship of the London and Home Counties Regional Advisory Council for Higher Technological Education (pp. 12; 1954; 1s.), details recommended standards of accommodation, books and equipment for such libraries. It is contemplated that the libraries concerned should not only provide books and accommodation for both staff and students but should also encourage the use of printed matter among students and act as a clearing-house for both external and internal information. Not less than three rooms should be provided: a reading room and library of at least 2,700 sq. ft., and smaller rooms for a work-room and storage, respectively. The position of the library is also important: it should be quiet but central. Professional advice is essential on equipment, which should follow standard patterns as far as possible. Sound-absorbing material is recommended for floor-covering, and liberal provision made for technical equipment, including a microfilm reader. Adequate lighting should be maintained at shelf- and table-level, and provision for hanging up the outdoor clothes of readers is essential. Generally, a minimum initial stock of ten thousand items is essential for an institutional library to function efficiently, but the value of any library administered by a qualified librarian is enhanced enormously by the provision of bibliographical aids. The capital cost of such a stock at 1954 prices would be not less than £10,000, and the stock would require replacement over each decade so that £1,000 a year must be allowed for this purpose, apart from improvements and current purchases, estimated at £500 a year or more. Work at advanced- and university-levels demands greater provision, particularly for periodicals, which represent an increasing charge. Binding and provision of photographic copies of articles not available in the library are further charges to be allowed for in the budget, and it is recommended that the librarian should attend meetings of boards of studies and teachers' conferences and be kept informed of any projected developments in the curriculum.

British Information Services Overseas

In opening an adjournment debate in the House of Commons on British Information Services on April 19, Dr. Horace King, who has recently returned from a lecture tour, on behalf of the Foreign Office, in the United States, Canada and Iceland, paid a warm tribute to the work already being done. More British people are needed abroad if Britain is to make her full contribution to world peace. Particularly he urged the extension of the work of British Information Services in Canada, and the fully

endorsed the findings of the Drogheda Committee that the Overseas Information Services play an important and essential part in support of British foreign, Commonwealth and Colonial policies; and that the work should be done well, continuously and on an adequate scale. His experience showed that the work being done in the New World met the criteria of quality, continuity and reliability which the Drogheda Committee laid down as essential if Information Services are to exert influence. Dr. King's remarks on the untoward effect of the press campaign which resulted from the report of the Select Committee on Estimates on the Foreign Service was endorsed by other speakers in the debate, and his whole speech was welcomed by Lord John Hope, Joint Under-Secretary of State for Foreign Affairs, who replied for the Government. Lord John Hope said that the Government is fully conscious of the good work being done in the embassies and is doing all that it can to encourage the exchange of teachers and students. He believes that the maintenance of friendly relations between the English-speaking peoples of the world is the most important single factor in the maintenance of peace.

Biophysical and Biochemical Cytology

THE first number of a new journal, *Biophysical and Biochemical Cytology*, appeared in January, edited by Richard S. Bear, H. Stanley Bennett, Albert L. Lehninger, George E. Palade, Keith R. Porter, Francis O. Schmitt, Franz Schrader and Arnold M. Seligman, and published by the Rockefeller Institute for Medical Research, Baltimore, Md. (published bimonthly, single issues 1.50 dollars, annual subscription 7.50 dollars). From the composition of the editorial board it appears probable that the new journal is intended primarily for the publication of researches carried out in the United States. The intention is "to provide a common medium for the publication of morphological, biophysical and biochemical investigations on cells, their components and their products. It will give special attention to reports on cellular organization at the colloidal and molecular levels and to studies integrating cytological information derived from various technical approaches". The provision of a new journal for publishing work on morphological studies and biophysical studies of cells, with particular emphasis on electron microscopy, will be a valuable service. It is to be hoped, however, that the more biochemical and cytochemical investigations will not be published in this journal, but in the journals which have hitherto made provision for work that is primarily cytochemical or biochemical in nature. The large number of journals that exist already gives rise to some difficulty in keeping in touch with some fields of research, and the primary purpose of journals for the publication of original research should be to bring together material which has a common technical basis.

Greenwich Observations during 1953-54

Two volumes, for 1953 and 1954 respectively, of the "Observations in Astronomy, Magnetism and Meteorology made at the Royal Observatory, Greenwich" have recently been published (pp. 405+12 plates, 90s. net, 1953; pp. 270+7 plates, 70s. net, 1954. London: H.M.S.O.). Corresponding issues for 1940, 1941, 1942, 1943 and 1944 have not yet been published, but those for 1940 and 1941 are expected from the printers very soon. The two volumes under

consideration follow the usual plan: section A, meridian astronomy, includes work on the transit circle, time service and variation of latitude. Section B, equatorial observations, does not appear in the 1954 issue because no equatorial observations were made in that year. Section C, photoheliographic observations taken at Greenwich, the Cape and Kodaikanal, includes the daily measures of positions and areas of sunspots and faculae, general catalogue of groups of sunspots, divided into recurrent groups and non-recurrent groups, total areas of sunspots and faculae for each day, mean areas of sunspots and faculae for each rotation and for the year, mean heliographic latitude of spots for each rotation and for the year, and observations of solar flocculi made with the spectrohelioscope. Section D, magnetic and meteorological observations, is followed by the report of the Astronomer Royal to the Board of Visitors for each year.

Mydriatic Alkaloids in Excised Root Cultures

T. M. STIENSTRA has pointed out that the literature contains few references to the formation of alkaloids in aseptic root cultures, and that the media used have not been entirely synthetic in composition. She now reports the formation of mydriatic alkaloids in excised root cultures of *Datura stramonium* grown in a completely synthetic medium (*Proc. Koninkl. Nederlandse Akad. Wetens.*, 57, No. 5, Ser. C, 584; 1954). Procedures for obtaining rapidly growing sterile root cultures from seedlings, the composition of the synthetic medium, and methods for extracting and identifying the alkaloids are described. Hyoscyamine appears to be the substance mainly present in the roots. The author reports that, in roots cultured for seventy-seven days, twenty-four times the amount of the alkaloid initially present was synthesized. In an addendum it is noted that the formation of alkaloids in excised root cultures of *Datura* and *Hyoscyamus* had already been described by O. F. Uffellie (*Pharm. Tijdschr. v. België*, 28, 65; 1951).

Joint Metallurgical Societies Meeting in Europe

THE leading metallurgical societies of Belgium, France, Germany, Great Britain and Sweden, together with representatives of the American Institute of Mining and Metallurgical Engineers and the American Society of Metals, will be meeting in Europe during June 1-18 to discuss technical and scientific developments in metallurgy and to see something of the various and diverse metallurgical industries in Europe. The proceedings will cover the following topics: iron-making (including coke and ore preparation); steel-making; mechanical working and heat treatment, both ferrous and non-ferrous (including hot and cold rolling, forging, wire-drawing and continuous casting, but not the foundry industry); refining and fabrication of non-ferrous metals; heat treatment; surface treatment (including finishing and coating); metallurgical education and training in industry; and research. The meetings will commence in Great Britain during June 1-7, when the Iron and Steel Institute and the Institute of Metals will be the joint hosts. The discussions will be held in London at Church House, Westminster, and visits will be made to a number of places of technical interest in or near London. In addition, five special tours, each lasting several days, have been arranged for a limited number of members to see one of the following metallurgical areas in Britain: South Wales, Birmingham, Sheffield and

Scunthorpe, Durham and Yorkshire, and Scotland. After the sessions in Great Britain, meetings will be held on the Continent of Europe as follows: June 9-12, Düsseldorf; June 13, Liège; and June 14-18, France (Paris and tours of northern, eastern, central and south-eastern France). Following these, tours are being arranged to other European countries, including Austria, Italy, Spain and Switzerland. Further information can be obtained from the Secretaries of the Iron and Steel Institute or the Institute of Metals, both of which organizations are at 4 Grosvenor Gardens, London, S.W.1.

Royal Institution: Officers

THE following have been elected officers of the Royal Institution: *President*, Lord Brabazon of Tara; *Treasurer*, Dr. L. H. Lampitt; *Secretary*, Mr. S. Robson; *Managers*, Mr. L. V. Chilton, Dr. A. Clow, Mr. E. R. Davies, Sir Alfred Egerton, Prof. A. V. Hill, Mr. L. B. W. Jolley, Dr. L. A. Jordan, Dr. A. R. Kagan, Dr. H. Lowery, Dr. A. C. G. Menzies, Mr. J. A. Oriel, Mr. W. E. Schall, Dr. J. H. Schulman, Mr. P. H. Schwarzschild and Dr. S. Whitehead; *Visitors*, Mr. W. W. Abson, Lieut.-Colonel S. J. M. Auld, Mr. W. Burrells, Major W. H. Cadman, Mr. A. D. R. Caroe, Mr. R. C. Chirnside, Dr. F. H. Cotton, Mr. W. A. Dickie, Prof. James Greig, Prof. Kathleen Lonsdale, Dr. R. Scott Russell, Mr. W. R. Stevens, Dr. Norman Stuart, Dr. D. T. A. Townend and Prof. H. E. Watson.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: R. G. Heath (deputy director, to be director of agriculture, Federation of Malaya); D. H. Laycock (agricultural officer, Nyasaland), tea research officer, Nyasaland; J. D. Kelsall (fisheries officer, East Africa High Commission), chief fisheries officer, East Africa High Commission; J. W. Pallister (senior geologist, Uganda), assistant director of geological surveys, Uganda; R. C. Anslow, senior agricultural officer (grassland and fodder), Mauritius; W. M. Barker, agricultural officer, Nyasaland; J. S. Boston, assistant surveyor of antiquities, Nigeria; C. G. Merton, assistant conservator of forests, Sarawak; A. H. Töthill, assistant conservator of forests, Uganda; J. R. Currie, pathologist, Sierra Leone; T. A. Rohan, senior specialist (organic chemist), West African Cocoa Research Institute, Gold Coast; T. M. Hurley, veterinary officer, Northern Region, Nigeria; D. G. Nelson, veterinary officer, Gold Coast.

Announcements

WE regret to announce the death of Dr. E. Morland, editor during 1937-44 of the *Lancet*, on April 26, aged eighty.

DR. W. HUME-ROTHERY, lecturer in metallurgical chemistry in the University of Oxford, has been elected to the George Kelley readership of metallurgy in the University as from October 1.

DR. WILLIAM REID, chairman of the Scottish Division of the National Coal Board, has been elected president of the Institution of Mining Engineers for the year 1956-57 and will succeed Major Noel Webster at the sixty-second annual general meeting to be held in London early next year. Dr. Reid, who is a graduate of the University of Edinburgh, was born in 1906 and has a family connexion with the coal-mining industry in Scotland covering a period of more than a hundred years, his father being the

distinguished mining engineer, Sir Charles Reid. He was appointed production member of the National Coal Board early this year.

THE Mathematics and Natural Sciences Faculty of the Technical University of Dresden has conferred an honorary doctorate on Prof. J. Heyrovský, of Prague, for contributions to electrochemistry by his work on polarography.

THE National Physical Laboratory, Teddington, is holding an open day on May 20. Admission is by ticket only and a limited number of invitations for the afternoon period 1.30-5.30 p.m. are available on application to the Director.

THE laboratories of the British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1, will be open to members of the Association and others during May 24-27 to mark the twenty-fifth anniversary of the establishment of the Association's laboratories in London.

THE Feeney chair of metallurgy in the University of Birmingham, vacant since the death in 1953 of Prof. D. Hanson, has been renamed the Feeney chair of physical metallurgy. Prof. G. V. Raynor, professor of physical metallurgy in the University (see *Nature*, 164, 819; 1949), has been appointed to the Feeney chair.

THE Textile Institute has awarded a research studentship to B. S. Hsu, of the College of Technology, Manchester, where he is at present engaged on research on the relaxation of tensile stress in synthetic fibres under different constant strains and at various humidities and temperatures. Mr. Hsu, who was born in Shanghai, came to England in 1951 and took a full-time degree course in textile technology at the Manchester College of Technology, graduating with first-class honours last year.

THE Chemical Society will be holding a symposium on the Friedel-Crafts reaction in the Department of Chemistry, University of Leeds, on May 18. The symposium is being specially arranged on the occasion of the visit of Prof. H. C. Brown, of Purdue University, to Great Britain. Further information can be obtained from the General Secretary of the Society at Burlington House, Piccadilly, London, W.1.

THE Department of Chemistry of the Israel Institute of Technology, Haifa, is holding a symposium on the chemistry of natural products during June 28-29. Of the ten scientific workers reading papers, three will be from the United States and two from Great Britain. Further information can be obtained from the professor of chemistry at the Institute, Prof. David Ginsburg.

MR. D. RIDER, 19 Portland Place, London, W.1, states that he has been asked by the British Lampblown Scientific Glassware Manufacturers' Association to prepare a history of the British lampblown scientific glassware industry, concentrating in the main on the past two hundred years. The industry is, of course, concerned with the manufacture of scientific apparatus by hand, but also covers the production of tubular glass containers and other glassware by machinery. He would be glad to receive information about the history of scientific glassware from the companies within the industry.

ERRATUM. In the communication "Reactions between Quinones and Proteins" in *Nature* of April 30, p. 771, absorption maxima should be in "mμ", not "μ" as printed.

MATHEMATICAL ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Mathematical Association for 1955 was held during April 13-16 at University College, Leicester, under the presidency of Prof. W. V. D. Hodge, Lowndean professor of astronomy and geometry in the University of Cambridge. On April 14 the presidential address, entitled "Changing Views of Geometry", was delivered. Prof. Hodge referred to the late nineteenth-century view, expressed by Klein in the famous Erlanger Program, that geometry deals with properties invariant under a group of transformations, and pointed out that this formulation had been to some extent misleading and is by now certainly inadequate. By the 1920's, geometry had become separated from the main stream of mathematics and was indeed suffering from a temporary exhaustion, though the development of birational geometry had shown the need to break the tyranny of the Erlanger Program. Prof. Hodge suggested that a geometry to-day might be described as the study of a space with a structure; he analysed the meaning to be attached to the words 'space' and 'structure', and showed that this description would help to re-integrate geometry into the main fabric of mathematics. Whether the geometer works directly from axioms or through an algebraic representation is, Prof. Hodge thought, largely a matter of taste; but he declared that what is required from young people entering a university with the intention of studying geometry is not any great ingenuity in solving tricky problems, but a thorough understanding of what geometry is about, and a sound knowledge of the elementary techniques of the subject.

Mr. A. Prag (Westminster School) spoke to the meeting on "Mathematical Literature", mentioning some of the key developments to be found in the classical works of the early mathematicians, and illustrating these by reference to some of the bibliophile's treasures to be found in the Association's own Library. This is housed at University College, Leicester, and though chiefly used as a postal lending library, it was on show to members during the meetings. On April 15, the first item was a paper by Prof. R. L. Goodstein (University College, Leicester) on "The Definition of Number". He showed the logical difficulties which arise in attempting to give a definition of whole numbers, the Frege-Russell class theory leading to antinomies while the Peano axiomatic method fails to specify a unique set. The extension of the number concept to positive and negative integers, fractions and complex numbers was also critically described. Following this, the Association proceeded to a discussion of its recently issued report on "The Teaching of Mathematics in Technical Colleges"; those opening the discussion were Mr. F. W. Kellaway (North Hertfordshire Technical College), Dr. H. Frazer (Gateway School, Leicester) and Mr. A. J. L. Avery (Derby Technical College). The details of the report were commended; but members showed some anxiety about the general relations between education in the secondary modern schools and in the technical colleges, and with the alleged excessive wastage during the course of the normal five-year curriculum of technical education. The Association was glad to hear that an increasing number of technical students find their way to a university degree.

The first item in the afternoon session was a discussion of "The Disadvantages of a Mathematical Education", led by Mr. W. O. Storer (Department of Education, University of Birmingham); Mr. Storer thought that the logical training supposedly given by mathematics might be arid, and that mathematical insistence on accuracy might lead to intellectual arrogance. Some members were reluctant to accept these inferences. In the next paper, "High-Speed Computers and their Application to Lens Design", Mr. W. M. Wreathall (Taylor, Taylor and Hobson, Ltd., Leicester) outlined the methods of obtaining the optical formulae required, and showed that the very laborious calculations needed in applying these formulae could now be handled readily by modern high-speed computers. After tea, Dr. Paul White (University of Reading) asked "What is the Matter with Negative Mass?". Dr. White asserted that the young research student must be prepared to question and to analyse fundamental assumptions, and illustrated the attitude of mind required by suggesting that the consequences of supposing that a particle might have negative mass could be examined. Some of these consequences are surprising, and Dr. White concluded by exhibiting, not entirely seriously, plausible reasons for believing that the original state of the universe consisted of equal quantities of particles of positive and negative mass, but that fluctuations of distribution had ultimately driven the negative masses to great distances. The final paper, on April 16, "The Applications of Statistics to Industry", by Mr. M. J. Moroney (chief statistician, Unilever, Ltd.), assumed that members were familiar with the mathematical elements of statistics and discussed, with much wit and force, the means whereby works managers could be made to understand that many of their production and distribution problems are amenable to treatment by statistical methods which can be explained in simple terms.

The president of the Association for the year 1955-56 is Mr. G. L. Parsons, of the Merchant Taylors' School, Sandy Lodge.

HYDRAULIC CONVEYING OF SOLIDS

THE tendency of process industries to-day to change from batch-wise to continuous operation is reflected in a renewed interest in pneumatic and hydraulic transport and a wider application of these systems to the conveyance of materials of all kinds. In both cases, the underlying principle is the application of forces to the solid by a conveying fluid travelling through a pipe-line in turbulent flow, so that the solid is carried forward in suspension at approximately the same velocity as the fluid in the case of hydraulic conveying, and at a rather lower velocity in pneumatic conveying. The mechanism is complicated; but the parameters involved can be identified and investigated in comparatively simple plant.

Although hydraulic conveying has long been used for handling a variety of materials, including gravels,

mine tailings, china clay and coal, no theoretical treatment has been proposed upon which the size of an installation and the power consumption for a specific duty can safely be based. The design engineer is still forced to rely on such published data as are available, relating to a restricted range of materials and operating conditions.

During recent years, however, systematic research has been in progress, notably in Britain and in France, in an effort towards obtaining a better understanding of the mechanisms involved. The results of some of this work were described in three papers read before the Institution of Chemical Engineers on March 15.

The first paper, by D. M. Newitt, J. F. Richardson, M. Abbott and R. B. Turtle (Department of Chemical Engineering of the Imperial College of Science and Technology, London), gave a brief summary of previous work and included an account of an experimental investigation into the behaviour of a wide variety of materials conveyed in a pipe of 1 m. diameter in a circulating system. Data were given for suspensions of graded solids from 0.0008 to 0.15 m. in diameter, specific gravities in the range 1.18–4.6, and volumetric concentrations up to 33 per cent.

It was shown that, over the range of velocities attainable in the system, five distinct modes of flow can occur, varying from fully suspended flow at high velocities to flow with a bed of solid moving at a uniform rate in the lower part of the tube, at low velocities. When pressure drop is plotted against velocity for a given concentration of suspended solid, a curve is obtained showing a minimum pressure drop at some critical value of velocity not far removed from that at which deposition occurs with subsequent choking. Some interesting observations were also made on the flow characteristics of suspensions of solids of mixed sizes. It appears that the transport of a coarse material may be facilitated by the admixture of a small proportion of fines, resulting in an increase in the overall carrying capacity of the system for a given pressure drop.

The results obtained with a 1-in. pipe can be correlated with reasonable accuracy by an equation based on simple theory. It is interesting to note that the equations are similar to the empirical relationships obtained by Durant, the only important difference being in the index of the pipe diameter term.

The second paper, by R. A. Smith, related to work carried out at the Billingham Division of Imperial Chemical Industries, Ltd., on the pumping of suspensions of sand in water through horizontal pipes of 2 and 3 in. in diameter. Measurements were made with closely sized and with mixed materials, and it was found that the pressure drop is always greater than that which would be obtained with a true fluid of the same density and viscosity as the suspension. With the non-uniform materials, the experimental results can be correlated with those for particles of a single size, by using a mean particle size, giving the same surface/volume ratio as for the mixture. The selection of a suitable pump, which will handle the suspension without serious risk of blocking and, at the same time, will have a reasonably high efficiency, is an important feature in the design of an installation. The pump used in the present work was of the centrifugal type, and was found to operate at an almost constant efficiency for volumetric concentrations up to 24 per cent.

In the third paper, by K. E. Spells (formerly with Imperial Chemical Industries, Ltd., Widnes, and now

at the R.A.F. Institute of Aviation Medicine, Farnborough, Hants), the experimental results of a number of workers were discussed, and a dimensional analysis of the variables of the process was attempted. It was shown that, in all cases, there is a minimum velocity at which transport can safely be effected, corresponding to the condition where particles start to fall out of suspension. As the velocity is increased, the pressure gradient tends towards that obtained with a true fluid of the same density and viscosity as the homogeneous suspension. Although this condition is approached asymptotically, Mr. Spells claims that it is generally possible to assess fairly accurately the 'standard' velocity at which the two pressure gradients coincide. The correlations are obtained with both vertical and horizontal pipe-lines, but are limited to conditions where the particle size is small compared with the pipe diameter.

D. M. NEWITT

J. F. RICHARDSON

EMBRYOLOGY OF MAMMALS

IN 1914, "Contributions to Embryology" was started to cater for those studies of the Carnegie Institution's Department of Embryology as were likely to prove too long and too lavishly illustrated for ordinary technical journals. Few ventures in scientific publication can ever have been better justified. The "Contributions" have become—what they promised to be at the beginning—the major single source of our information about mammalian embryonic development. The earlier volumes were devoted chiefly to descriptions of human embryos, and to accounts of placentation and the development of the systems of the body. Franklin P. Mall, who initiated the publication, and who was the Department's first director, was also keenly interested in the study of the mammalian reproductive cycle. The "Contributions" have, therefore, also had a profound influence on the development of experimental endocrinology. Vol. 2, published in 1915, carried an article by G. W. Corner, the present director, on the corpus luteum of gestation. Corner's analysis of the phases of the menstrual cycle in the rhesus monkey appeared in 1923, and in 1927 the "Contributions" published the first major experimental study, by the late Edgar Allen, of the hormonal basis of the primate reproductive cycle. The study of primate reproduction was taken an important step forward in 1933 with a description, by Lewis and Hartman, of the segmenting human ovum. Then, in 1941, side-by-side in the same volume, there appeared an account by Hartman and Corner of the first segmentation division of the fertilized egg of a monkey, and a description, by Hertig and Rock, of segmenting human ova no older than eleven to twelve days.

Vol. 35, which has recently been published*, goes yet further. In addition to a series of distinguished monographs that deal with regional embryological studies (among which is one by Bartelmez and Blount on the formation of the neural crest in man), as well as several of a more experimental kind (including one by Wells and van Wageningen on the induction of pseudo-hermaphroditism in monkeys), the volume provides a further description, by Corner and Bartelmez, of early embryos of the rhesus

* Contributions to Embryology, 35, Publication No. 603, Nos. 231–241 (1954). Pp. 237 + 54 plates + 57 figs. 12 dollars paper bound, 13 dollars cloth.

monkey; and an account by Hertig, Rock, Adams and Mulligan of four normal and four abnormal human ova ranging in age from the fifth day of development to as little as one day after fertilization. These showed, *inter alia*, that the human blastocyst is prepared for implantation slightly more rapidly than the monkey egg.

It is odd to think that until relatively recently the number of early human embryos that have been studied was so few that almost each had a name. The enormous increase in the amount of material that has become available for study is a direct consequence of the interest in the whole of this problem that has been generated by the Carnegie Department of Embryology. It is also a direct outcome of the researches on reproduction in which the Department has played so big a part, and which have made it possible to estimate when ripe follicles will be present in the ovaries, and when ovulation is likely to occur. Armed with this knowledge, it is possible to time certain types of operation that have to be carried out so as to increase the chances of recovering, for scientific study, the human egg in its first stages of development. The latest chapter of the story is not, however, told in Vol. 35 of the "Contributions". The December 1954 issue of the *Transactions of the New York Academy of Sciences*, and the February 1955 number of the *American Journal of Obstetrics and Gynecology*, include articles by Landon B. Shettles describing the *in vitro* fertilization of the human ovum and its transformation into an eight-cell morula. This is a great technical achievement, and it opens up the possibility of exploring still further some of the most basic problems of human development.

S. ZUCKERMAN

ELECTRICAL PROPERTIES OF WOOD

THE electrical properties of wood are of importance in high-frequency heating processes, in the use of wood as an insulator, and in the determination of moisture content by electrical means. Whereas the direct-current behaviour of wood can be specified solely by the electrical conductivity, the alternating-current behaviour requires two quantities—the relative permittivity (or dielectric constant) k , and the loss tangent $\tan \delta$ —for its specification. In order to assess the effect of frequency, grain direction and moisture content on the dielectric properties of wood, R. F. S. Hearmon and J. N. Burcham have recently measured k and $\tan \delta$ for twelve different species of wood in the three grain directions, at moisture contents up to 18 per cent and more, the frequency range being 2 kc./s.–60 Mc./s.*. The specimens were in the form of disks, approximately 5 cm. in diameter and 0.6 cm. thick, and tin-foil electrodes were attached to the flat faces with a thin film of 'Vaseline'.

The results for the two species, sitka spruce and oak, representing medium-light and medium-heavy timbers respectively, are presented and discussed in some detail. The permittivities change uniformly with moisture content and frequency, being closely related to the density, and a method is suggested by which the permittivities of any timber may be predicted approximately in terms of the density, moisture content and frequency. The inter-relationship

between loss tangent and these three quantities is, however, highly complex, and it is not possible to predict values of $\tan \delta$ with any accuracy. A few measurements were made, in addition, on oak of moisture content 75 per cent and on wych elm of moisture content 70 per cent, and although k and $\tan \delta$ varied considerably with frequency, the electrical conductivity did not change greatly over the frequency range 1–100 kc./s. It is concluded that for low moisture contents the results are in accord with the qualitative description of the dielectric behaviour of wood, which can be given in terms of the dipolar mechanism of electrical conduction, but that for high moisture contents the effect of ionic conductivity becomes of greater importance and must be taken into account.

CACAO RESEARCH

THE staff of the Cacao Research Scheme at the Imperial College of Tropical Agriculture, Trinidad, comprises plant breeders, physiologists, soil chemists, a biochemist, a mycologist, an entomologist and estate personnel. The aim of the research programme is to improve the yield and quality of cacao beans, that is, it is essentially of an applied character, such fundamental research as may be undertaken being in direct relation to practical needs. In the Report for 1953 now published (obtainable from Trinidad or from the London Office, 40 Norfolk Street, W.C.2; November 1954; 10s. 6d.) an account is given of research completed, research in progress and research contemplated.

An interesting account is given of the 1952–53 collecting expedition to Colombia. This includes full notes on the different forms of cacao (*Theobroma cacao*) observed, together with some thirteen other species which were collected, and ten species of the related genus *Herrania*. This venture also yielded valuable information on the insects, and their parasites and predators, associated with these plants, and on the incidence of the witches' broom and *Monilia* fungal diseases. Many of the new materials have now been established in Trinidad. A more general result of the expedition has been to support the view that the centre of origin of cacao probably lies near the Colombian–Equadorian frontier on the eastern flanks of the Andes.

Experiments on the effects of shade and fertilizer applications have shown that, as light intensity increases, the trees become more vigorous but, at 75 and 100 per cent light, growth is dependent on fertilizer treatment: in the absence of additional nitrogen the plants are stunted, but with nitrogen they are very vigorous, yielding considerable lateral branching and a closed canopy. The mean yield increases with increasing light intensity up to 50 per cent light; thereafter it decreases progressively. This trend is, however, reversed by nitrogen additions, maximum yields being recorded at 75 per cent light. Light is especially important in determining the duration of the cropping period. At low light intensities there is a steady production of pods but no peak harvest, whereas with 50 per cent light, or more, all pods mature in a peak period. Fertilizer applications both advance the onset of harvesting and yield a distinctive peak as compared with the controls.

A new, effective and relatively cheap technique for the rooting of cacao cuttings has now been suggested. Baskets of soil, with a central core of composted

* Forest Products Research Special Report No. 8. The Dielectric Properties of Wood. By R. F. S. Hearmon and J. N. Burcham. Pp. +20. (London: H.M.S.O., 1954.) 1s. 6d. net.

sawdust, are prepared and the cutting inserted in the compost, one per basket. The cuttings are then rooted in a shaded glasshouse with controlled humidity at 100 per cent. It is stated that one unit could supply 30,000 plants ready for field planting.

Techniques for the complete study of the contents of a single pod have been taken a stage further by the use of an improved microfermentary. Improvements have also been effected in the solar fermentary, which is of a capacity intermediate between the normal fermentation box (or sweatbox) and the microfermentary.

Other papers in this report are concerned with such topics as physical measurements of soil, the effect of shade and of mulching on soil temperature, nitrogen partition in the normal cacao leaf (as a contribution to an understanding of the rate of development of some pest populations), the susceptibility of various selections to witches' broom disease, spraying against this disease, and various entomological and cultural studies. Researches in progress and those contemplated are also briefly annotated.

MICRO-FOSSILS IN EARLY FLORAS

ATTENTION has been directed to the important bearing of certain micro-fossils on our knowledge of the nature and composition of Pre-Carboniferous floras in Canada by N. W. Radforth and D. C. McGregor (*Canadian J. Bot.*, **32**, 5, 601; 1954).

It has now been ascertained that, in Canada, rocks of Devonian age are associated with the occurrence of oil and gas. In some of these oil-yielding areas, which present serious difficulties to the stratigrapher because of the presence of 'unfossiliferous' sediments, that is, barrenness of plant remains as macro-fossils, it appears that the investigation of the micro-fossils is likely to afford a tool of practical value, and to yield information of very great interest to the palaeobotanist; for the Devonian period has long been held to be one of critical importance in the evolution and development of the flora of the land.

Fifty-six recently discovered spores and spore-like micro-fossils from Canadian non-coaly deposits of Middle and Upper Devonian age have now been described and classified by these investigators. The manner of occurrence of these fossils suggests that they may probably be useful in ascertaining biostratigraphical entities and in the further investigation of oil-bearing rocks.

In relation to the evolution of plants, these micro-fossils afford evidence of a more complex and more highly evolved Devonian flora than has been apparent from the macro-fossil record. Furthermore, preliminary investigations have disclosed spores of comparable abundance and of only slightly less complexity in rocks of Lower Devonian and Silurian age.

On the preliminary evidence now presented, that is, of the existence of large and diversified spore populations in different strata, even in those of Lower Devonian and Silurian age, it appears that the land flora of the Devonian period was both varied and extensive, this being contrary to the commonly held view. The discovery of relatively complex micro-fossils in Silurian rocks containing *Monograptus* is important from the botanical point of view: it indicates that the complexity of form and structure

which are normally associated with the vascular plants probably came into existence very much earlier than has usually been assumed, that is; on the evidence derived from the study of such stems, leaves and sporangia as have come to light. Special interest is attached to a Devonian micro-fossil which in appearance resembles angiosperm pollen, though, as the authors are careful to point out, any conclusion about it at this stage would have to be viewed with the greatest caution.

RESPIRATORY PIGMENTS OF RHODOSPIRILLUM RUBRUM

By DR. BRITTON CHANCE and
DR. LUCILE SMITH

Johnson Foundation, University of Pennsylvania

SENSITIVE spectroscopic methods for recording differences of optical density between aerobic and anaerobic suspensions of many types of bacteria have made possible accurate identification of the patterns of their cytochromes, flavoproteins and pyridine nucleotide enzyme systems¹. We report here a study of the respiratory pigments of *Rhodospirillum rubrum*, the bacterium in which Duysens² and Vernon and Kamen³ have concluded that a cytochrome with an absorption spectrum similar to that of cytochrome *c* is oxidized in a photochemical reaction.

Spectroscopic changes occurring when the aerobic bacterial suspension became anaerobic were recorded at a series of different wave-lengths from 650 to 390 mμ (as in Fig. 1A) by means of a double-beam apparatus⁴. In each case the difference between the given wave-length and some reference wave-length was recorded; this eliminated any interference which might have resulted from changes in the light-scattering properties of the bacteria. In some experiments the difference in optical density between two forms of the pigments in two different cuvettes was recorded by means of a split-beam instrument⁵, as illustrated in Fig. 1, B and C. Photochemical effects upon the spectrum (Figs. 2 and 3) were recorded with the same apparatus that was developed for measuring the photodissociation difference spectra of the carbon monoxide compounds of cytochrome oxidases⁶. Here infra-red illumination was obtained from a tungsten lamp through two thicknesses of Wratten 88A filter plus Corning 2424. Neutral filters of density between 0.5 and 2.0 were also added until the observed effect of illumination of aerobic cells was very small, similar to that illustrated in Fig. 3A. The bacteria were obtained through the kindness of Dr. M. D. Kamen and were grown as described by him⁷, except that tap water and twice the concentration of yeast extract and biotin were used. For measurements in the Soret region of the spectrum, cells obtained after two to three days growth were used directly; these had an optical density at 800 mμ of about 1.0 cm.⁻¹. Denser suspensions for use in the visible region of the spectrum were obtained by centrifuging the cells, then suspending them in the supernatant fluid.

Dark Reactions of the Pigments

The difference spectra plotted in Fig. 1A and Fig. 2A, curves *a* (difference in optical density

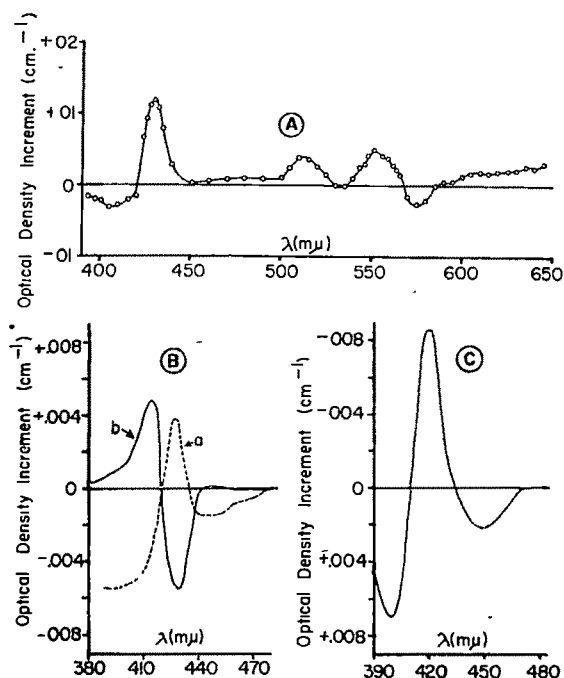


Fig. 1. (A) Differences of optical density occurring when an aerobic suspension of *Rhodospirillum rubrum* becomes anaerobic. Changes observed at wave-lengths indicated with the double-beam apparatus; reference wave-length, 450 μμ.

(B) Shift of the Soret band caused by adding carbon monoxide to anaerobic bacteria; measurements made with the split-beam instrument. *a*, aerobic bacteria in the reference cuvette and anaerobic cells in the other cuvette; *b*, anaerobic cells in the reference cuvette and anaerobic cells plus carbon monoxide in the other cuvette (pure carbon monoxide for 30 sec.)

(C) Effect of phenylmercuric acetate (0.1 mM) upon the Soret band of aerobic bacteria, recorded in the split-beam instrument. Aerobic cells in the reference cuvette and aerobic cells plus the inhibitor in the other cuvette. Since the absorption bands of reduced cytochrome *c* disappear, decrease in optical density is plotted upward (Exp. 397)

between the reduced and steady-state oxidized pigments) give an insight into the respiratory pigments present in the organisms. The peak in the visible region of the spectrum at 550 μμ corresponds to the cytochrome *c*₂ isolated from the bacteria by Vernon⁸. The shoulder at about 563 μμ indicates that a cytochrome of type *b* is also present. Although there is sometimes observed a small deflexion in the difference spectrum around 590 μμ, there is no positive identification of cytochromes *a*, *a*₁ or *a*₂. The main absorption band in the Soret region of the spectrum is at 428 μμ, which is characteristic of the cytochromes of type *b*, and is mainly due to a pigment which reacts with carbon monoxide, as is shown by the considerable disappearance of the band at 428 μμ when carbon monoxide is added to the reduced form of the pigments (Fig. 1B). The difference spectrum of the carbon monoxide compound has a peak at 415 μμ and is very similar to that of a terminal respiratory enzyme found in several kinds of micro-organisms⁹. This carbon monoxide-binding pigment, which may also be the terminal respiratory enzyme of these bacteria, could be identical with a pigment isolated from *Rhodospirillum rubrum* by Vernon and Kamen¹⁰.

The reduced minus steady-state oxidized difference spectrum of *Rhodospirillum rubrum* differs from those of numerous other bacteria in the relationship of the heights of peaks¹¹; the peak around 515 μμ is large and that at 428 μμ is small in relation to the peaks

at 550–563 μμ. This may mean that changes of optical density due to pigments other than the cytochromes are apparent in the visible region of the spectrum. Also we have not yet found evidence of spectral changes due to flavoprotein or pyridine nucleotides in any of the difference spectra recorded.

If phenylmercuric acetate is added to the aerobic bacteria (to a final concentration of 0.1 mM), the respiration of the bacteria is inhibited and the strong band at about 420 μμ in the absorption spectrum (Fig. 1C) and a smaller one at 550 μμ disappear. This must be attributed to the oxidation of cytochrome *c*, which is apparently largely reduced in the aerobic state. From a comparison of spectra such as that in Fig. 1C with Fig. 1A, it was calculated that the cytochrome *c* was about 60–70 per cent reduced in the aerobic steady-state.

Reactions of Pigments on Illumination

Fig. 3A is a recording by the double-beam apparatus of the optical density changes at 430 μμ minus 440 μμ when the bacteria were illuminated in both the aerobic and the anaerobic states; Fig. 2A shows these changes of optical density at different wavelengths in the Soret and visible regions of the spectrum. With the light intensity used, illumination of the aerobic organisms produced only small effects. Illumination of the anaerobic organisms resulted in changes of optical density similar to those observed

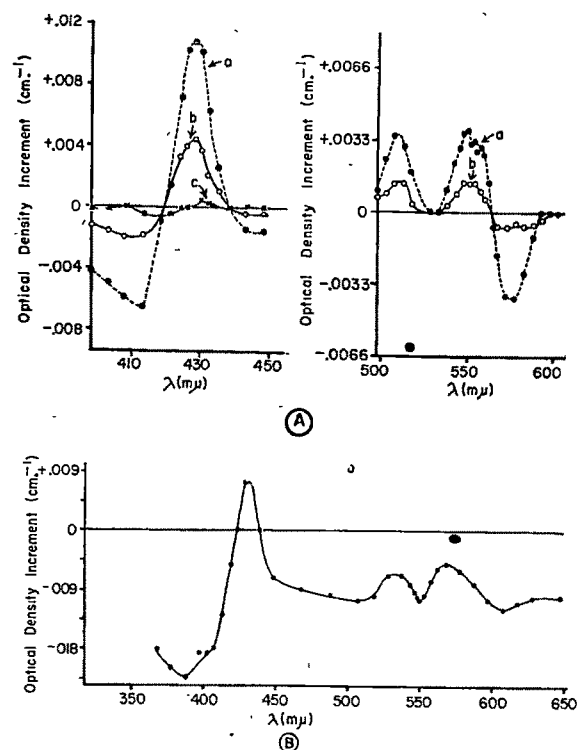


Fig. 2. (A) Comparison of the spectroscopic effects of oxygen and infra-red illumination, recorded in the double-beam instrument at the wave-lengths indicated. *a*, Absorption bands of respiratory pigments that appear when the bacteria become anaerobic; *b*, those appearing upon cessation of infra-red illumination; *c*, changes of optical density on cessation of illumination of the aerobic bacteria. The spectra in the visible and Soret regions were measured with different samples of bacteria

(B) Absorption bands appearing upon infra-red illumination of aerobic bacteria treated with phenylmercuric acetate (final concentration = 0.1 mM), recorded with the double-beam instrument. Reference wave-length 440 μμ (Exp. 399)

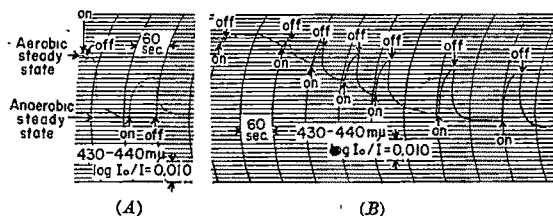


Fig. 3. Recording from the double-beam spectrophotometer: (A), illustrating the kinetics of the reduction of the cytochromes as the suspension becomes anaerobic, as well as the effects of illumination of both aerobic and anaerobic cells; (B), showing increase in optical density changes on illumination with increasing reduction of cytochrome. Carbon monoxide was added to prolong time of reduction of the cytochromes (Exp. 398).

on aeration, as shown in curves *a* and *b* of Fig. 2*A*; but the change following illumination was always smaller, usually reaching a value of 50–80 per cent of that observed on aeration. The spectrum of the changes in optical density following illumination is similar to that reported by Duysens², but we have been able to obtain more detail in the visible region. Our results indicate that the whole cytochrome system of the bacteria, rather than the cytochrome *c*₂ only, becomes partially oxidized on illumination. The effect does not seem to result from the production of oxygen, since van Neil could find no evidence for production of oxygen on illumination of the organisms¹², and we observed the same changes of optical density when the bacteria were illuminated in the presence of 1 mM sodium hydrosulphite. The anaerobic light effect clearly increases in proportion to the extent of reduction of the cytochromes, as shown in Fig. 3*B*; but inhibitors of the oxidation of the cytochromes, such as 3 mM cyanide or 1 mM carbon monoxide, do not inhibit the changes in optical density following illumination of the anaerobic cells.

The results do not agree with the suggestion of Vernon and Kamen³ of a photo-oxidation of cytochrome c_2 , for we find that cytochrome c_2 remains largely reduced when aerobic cells are illuminated, and the illumination of the anaerobic cells does not produce as large an effect as addition of oxygen. The photo-oxidation investigated by Vernon and Kamen resulted from high light intensities and was found to require oxygen; thus it may not be related to the changes following low-intensity illumination of the anaerobic cells.

If the aerobic bacteria treated with 0.1 mM phenylmercuric acetate are illuminated with the same low infra-red intensities as were used to obtain the observations of Fig. 2A, an absorption band rapidly appears that has a peak at 432 mμ in the Soret region (Fig. 2B). This peak corresponds very closely to that of the reduced form of the cytochrome that combines with carbon monoxide (Fig. 1B). The peaks in the visible region of the spectrum are not positively identified and may, in part, be due to an additional pigment. (This difference spectrum has a certain resemblance to that of an oxy-haemoglobin compound or a complex II of peroxidase. But neither oxygen nor peroxide causes this spectrum to appear; illumination of the aerobic mercury-inhibited cells is required. It is possible that an oxidation of unidentified material by (OH) also occurs simultaneously with the photo-reduction reaction.) The reduction of

the pigment on illumination is suggestive of the reduction of ferrimyoglobin on illumination of chloroplasts¹³.

The kinetics of the changes in optical density following illumination may be diphasic, depending upon the wave-lengths employed, which confirms that illumination affects a series of cytochromes, not just a single one. During both anaerobic illumination and aerobic illumination in the presence of phenylmercuric acetate, the absorption band found to respond most rapidly to illumination is that at about 430 mμ.

The hypothetical scheme of Fig. 4 provides a framework for explaining the experimental observations on the assumption that the cytochrome chain which reacts with oxygen can also react with the products of the photolysis of water. The respiratory chain has as its terminal enzyme a carbon monoxide- and cyanide-sensitive oxidase. Cytochrome c_2 is largely reduced in the aerobic steady-state because of the large ratio of reductase to oxidase activity for this component; but it becomes oxidized upon inhibition of reductase activity by phenylmercuric acetate. In the absence of this inhibitor, an oxidant, such as hydroxyl radicals derived from the photolysis of water¹⁴, can react with the oxidase, as evidenced by the inhibition of respiration on illumination¹⁵ and by the anaerobic oxidation of the cytochrome system. The reaction of the oxidase with hydroxyl radicals differs from its reaction with oxygen in that the former reaction is not inhibited by carbon monoxide or cyanide. A direct oxidation of cytochrome c_2 by hydroxyl radicals is unlikely, since it does not occur aerobically. In the mechanism pictured, the oxidase could be either oxidized or reduced by the products of the photolysis reaction; but a photosynthetic hydrogen acceptor system of high activity would cause the oxidation reaction to predominate during illumination and to be followed by a rapid reduction due to accumulated reducing substances (either (H) or HX of Fig. 4) that can react directly with the oxidase (Fig. 3B shows that the reduction of cytochrome following illumination is faster than the rate caused by cell respiration); The photoreduction observed in the presence of phenylmercuric acetate could be caused by a decrease in the concentration of (OH) or an increase of (H). Two alternative mechanisms are suggested: one an inhibition of carbon dioxide fixation (as is clearly established in other systems, see for example ref. 16); and the other an inhibition of the accumulation of

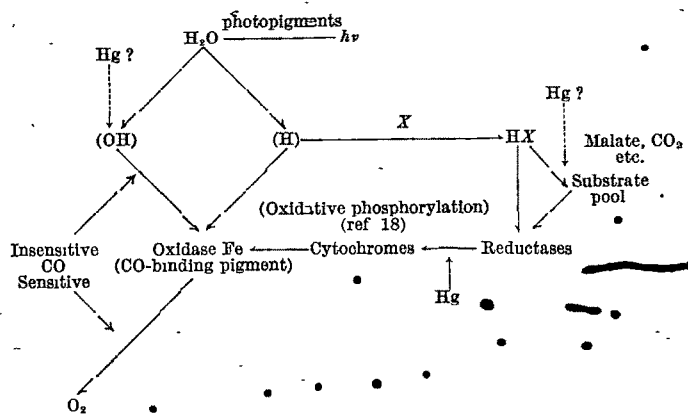


Fig. 4. Hypothetical scheme to explain spectrophotometric effects in *Rhodospirillum rubrum*

hydroxyl ions. In the latter case the hypothetical configurations of thioctic acid¹⁷ combined with the photolysis products of water could afford a basis for selective inhibition of (OH) production by phenylmercuric acetate.

This research was supported in part by the United States Public Health Service and the National Science Foundation.

[Dec. 1

¹ Chance, B., *Nature*, 189, 215 (1952). Chance, B., Smith, L., and Castor, L. N., *Biochim. et Biophys. Acta*, 12, 289 (1953) Smith, L., *Bact. Rev.*, 18, 106 (1954).

² Duysens, L. M. N., *Nature*, 173, 692 (1954).

³ Vernon, L. P., and Kamen, M., *Arch. Biochem. Biophys.*, 44, 293 (1953).

⁴ Chance, B., *Rev. Sci. Instr.*, 22, 619 (1951).

⁵ Yang, C. C., and Legallais, V., *Rev. Sci. Instr.*, 25, 801 (1954).

⁶ Chance, B., *J. Biol. Chem.*, 202, 397 (1953).

⁷ Gest, H., Kamen, M. D., and Bregoff, H. M., *J. Biol. Chem.*, 182, 153 (1950).

⁸ Vernon, L. P., *Arch. Biochem. Biophys.*, 43, 492 (1953). Elsdon, S. R., Vernon, L. P., and Kamen, M. D., *J. Amer. Chem. Soc.*, 75, 6347 (1953).

⁹ Chance, B., *J. Biol. Chem.*, 203, 383 (1953). Castor, L. N., dissertation, Univ. Pennsylvania (1954).

¹⁰ Vernon, L. P., and Kamen, M. D., *Fed. Proc.*, 13, 314 (1954).

¹¹ Smith, L., *Arch. Biochem. Biophys.*, 50, 299 (1954).

¹² Van Nell, C. B., "Adv. Enzymol.", 1, 236 (1941).

¹³ Hill, R., and Searlsbrick, B., *Proc. Roy. Soc., B*, 129, 238 (1940).

¹⁴ Hill, R., *Proc. Roy. Soc., B*, 127, 192 (1939).

¹⁵ Johnston, J. A., and Brown, A. H., *Plant. Physiol.*, 29, 177 (1954).

¹⁶ Aron, D. I., Allen, M. B., and Whatley, F. R., *Nature*, 174, 394 (1954).

¹⁷ Barltrop, J. A., Hayes, P. M., and Calvin, M., *J. Amer. Chem. Soc.*, 76, 4348 (1954).

¹⁸ Frankel, A., *J. Amer. Chem. Soc.*, 76, 5568 (1954).

APPLICATION OF BIOMETRIC METHODS TO PROBLEMS OF CLASSIFICATION IN ECOLOGY

By R. ELFYN HUGHES*

The Nature Conservancy, Bangor

AND

D. V. LINDLEY

University Statistical Laboratory, Cambridge

THE application of Fisher's development of multivariate analysis for discriminatory purposes¹ to problems of plant taxonomy and plant community classification has recently been explored by Whitehead², Goodall³ and Hughes⁴.

Mahalanobis, and more recently Rao⁵, have used a multivariate analysis technique based on the statistic D^2 , calculated from the means, variances and covariances of the quantities measured in the two groups. More precisely, if p quantities have been measured, a_{ij} is the dispersion matrix ($i, j, 1, 2 \dots p$) supposed common to the two groups, and d_i is the difference between the means in the two groups for

the i th quantity, then $D^2 = \sum_{i,j=1}^p a_{ij} d_i d_j$ with a^{ij} the matrix inverse to a_{ij} . D^2 is a measure of the 'distance' between the two groups; the larger D^2 is, the more difference exists between the two groups in terms of the p quantities measured. D^2 's between different pairs of groups may be compared. D^2 may also be used as a test of significance to see if any real differences exist between the two groups, based on the characters which have been studied; and in the case of $p = 1$, it reduces to the familiar Student's

t -test. The use of this function opens a wide field for its application in ecology.

One use lies in the study of plant communities, where D^2 can be used as a coefficient of similarity between two communities⁴.

In Table 1 a summary is given of an example where two communities are compared. From the data the following discriminant function was obtained:

$$9.430008xA + 8.646360xB + 13.375968xC + 0.205926xD$$

$$xA = \log(A + 5), xB = \log 10B, xC = \sqrt{G + 0.375}, xD = \sqrt{D + 0.375}$$

The standard errors of the coefficients are respectively: 0.399387, 0.147219, 0.091873 and 0.082622. The D^2 value is 11.647785, which is significant at less than 0.1 per cent probability (ref. 5, pp. 247-48). Hence a real difference exists between these communities according to the species groups which have been studied. This may be extended to several groups and the D^2 for each pair calculated, as has been done by Rao⁵ for human races. In this way a 'constellation' of relationships has been worked out for a group of six Snowdonian soil series. The classificatory details of the soil series are set out in Table 2. From the study of the four soil characteristics of exchangeable calcium, potassium, pH and available phosphate, the variate ranges of the quantitative data for each of these characteristics showed considerable overlap from soil series to series. The statistical validity of the classification outlined in Table 2 has therefore to be considered. The means and the variances for each characteristic are set out in Table 3 (because of non-normality of distribution the original quantities have been transformed).

The values of D^2 are set out in Table 4. This enables the original classification to be tentatively revised so that we have only four soil series:

(a) Soil series derived from pumice tuff and dolerite rocks under rainfall ranges of approximately 42.5-55 in. and 75 in. mean annual rainfall respectively (series A and C).

(b) Rhyolite soils developed under a rainfall range of 35-60 in. (series B).

(c) Pumice tuffs and rhyolite soils at high-rainfall (60-150 in. and 65-150 in. mean annual rainfall

Table 1. DIFFERENCES BETWEEN TWO PLANT COMMUNITIES
Oak scrub (hybrids of *Quercus robur* and *Q. petraea*). Alt. = 200-800 ft.,
Conway Valley, North Wales

Ecological class of species within communities	Mean prominence (scale 1-10) of species class in community on soil series		Difference (R-P)
	R (n = 15)	P (n = 22)	
A	1.28	4.09	-2.81
B	2.80	2.28	+0.52
C	2.90	0.44	+2.46
D	2.42	3.07	-1.65

Class of species: A, spp. of *Quercus robur*; B, spp. of *Q. petraea*; C, spp. of heaths and acidic grasslands; and D, spp. of agricultural grassland.

Soil series: R, free-draining soils derived from rhyolite (acidic); P, free-draining soils derived from pumice tuff (basic).

Table 2. CLASSIFICATION OF SOME SNOWDONIAN SOILS

Soil parent rock	Rainfall range		Soil series No. of sites		Rainfall range*		No. of sites	
	A	B	A'	B'	C'			
Pumice tuff (basic)	42.5-55	37.5-60	26	18	60-150	36		
Rhyolite (acidic)	42.5-75	42.5-75	59	59	65-150	22		
Dolerite (basic)					85-135	9		

* Rainfall range in terms of mean annual rainfall in inches

* The greater part of the work reported on here was carried out while at the School of Agriculture, Cambridge.

Table 3. MEAN SOIL CHARACTERISTICS OF SIX SNOWDONIAN SOIL SERIES

Soil series	No. of sites	Exchangeable CaO	Available P ₂ O ₅	Exchangeable K ₂ O	pH
A	26	239.84	2.86	17.21	5.11
A'	36	93.33	1.80	12.45	4.81
B	18	97.23	4.95	20.72	4.52
B'	22	85.86	1.02	10.94	4.51
C	59	205.53	3.57	21.37	4.95
C'	9	103.80	1.74	23.67	4.64

All soil quantities other than pH in mgm. per 100 gm. air-dry soil. Individual variates are weighted means per soil profile.

TRANSFORMED QUANTITIES

Soil series	$\bar{W}$	Variance	$\bar{X}$	Variance	$\bar{Y}$	Variance	$\bar{Z}$	Variance
A	2.322	0.05589	1.446	0.08587	1.319	0.32874	0.705	0.00174
A'	1.900	0.06601	1.216	0.11450	1.196	0.38020	0.678	0.00237
B	1.891	0.11140	1.569	0.15426	1.306	0.39024	0.652	0.00255
B'	1.798	0.09900	1.103	0.07082	1.140	0.36632	0.650	0.00267
C	2.236	0.06004	1.496	0.07786	1.367	0.34488	0.692	0.00181
C'	1.957	0.06558	1.207	0.13040	1.420	0.33885	0.662	0.00524

$\bar{W} = \log (\text{CaO})$; $\bar{X} = \log (10 \text{ P}_2\text{O}_5 + 5)$; $\bar{Y} = \log (\text{K}_2\text{O} + 5)$; $\bar{Z} = \log (\text{pH})$
Transformations to achieve normality of distribution and equality of variances

Table 4. D^2 ANALYSIS OF SNOWDONIAN SOIL SERIES (Index to series see Table 2)

	A'	B	B'	C	C'
A	2.66	3.66	4.46	0.26*	3.07
A'		1.91	0.30*	2.18	1.44
B			2.44	2.21	2.48
B'				3.76	1.78†
C					2.09†

* Not significant; † significant at 5 per cent; ‡ significant at 1 per cent; all others significant at 0.1 per cent. Analysis based on the four soil characteristics of Table 3.

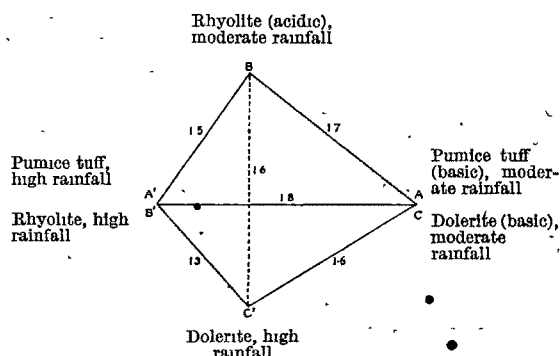
respectively) can be classed as one group (series A' and B').

(d) Dolerite soils at high rainfall (85–135 in. mean annual rainfall) can be classed in a single group (series C').

Since only four soil characteristics have been studied, this re-classification can only be tentative. This is emphasized in the case of pumice tuff and rhyolite soils at high rainfall, as vegetational differences exist between them.

It is, however, suggested that the present revised classification is a useful 'working' one for ecological purposes, since the four soil properties studied are of known importance to plant growth.

The results are shown diagrammatically in Fig. 1 as a 'map' with points representing the four soil groups, the distances between the points being proportional to D^2 . Such a representation of the structure of classificatory relationships can be of value in that the statistical distances (and their significances) between the units can be clearly seen.

Fig. 1. Map of soil types based on D^2

The present investigation stresses the need for a statistical appraisal of the validity of the classificatory groups established on empirical grounds.

The same example has been considered also from a discriminatory point of view. Thus, suppose we have a chemical analysis of the type described above for a new soil known to be one of the four types isolated by the above analysis. It is possible by a canonical analysis to classify it in the correct class, with, of course, certain possibilities of error which will be smaller the larger the value of D^2 . A canonical

analysis has been carried out for the same data as used above, and it shows that three linear discriminants are needed. They are: (i) $W + 0.29X + 0.25Y + 0.40Z$; (ii) $W - 1.98X - 0.60Y + 6.31Z$; (iii) $W - 9.21X + 21.35Y - 34.76Z$.

These discriminant functions would be used in the following manner. If (ii) is less than 2.4 for the new analysis, the soil is classified as (b) above. If (iii) is less than -5.0, the soil is classified as (d). If the soil is unclassified by (ii) or (iii), then (i) is used; if this is less than 3.05, it would be classified as (c), and if greater, as (a).

The following applications of these methods are suggested:

(1) The structure of the classificatory relationships for series derived from the same parent rocks could be compared for a different range of rainfall gradients and other related climatic factors.

(2) Trends in soil development which can be related to specific factors, such as a rainfall gradient as considered here, can be given a quantitative expression, through the distance function D^2 . This could be instructive if one or more of the classificatory units are typical of a well-established soil group, or an example of such a group or groups could be introduced into the analysis. The degree and significance of the departure of the soils studied from these typical examples could therefore be expressed in terms of D^2 .

(3) Similar considerations apply to the study of plant communities. Trends away from, or towards, a particular kind of community can be expressed, in terms of D^2 . These might be ascribed to particular environmental factors. Developmental successional trends could also be expressed in a similar manner.

(4) The collation of the D^2 analyses of soil factors (or any other environmental factors) and of related vegetational characteristics could give a quantitative estimation of the part played by a group of particular environmental factors in determining vegetational trends. Here the use of canonical correlation would be an important development.

[Dec. 15]

¹ Fisher, R. A., *Ann. Eugen.*, 7, 179 (1936).

² Whitehead, F. H., *New Phytol.*, 53, No. 3, 496 (1954).

³ Goodall, D. W., *Aust. J. Bot.*, 1, No. 3, 434 (1953).

⁴ Hughes, R. E., VIIIe Congrès International de Botanique, Paris, 1954, Rapports et Communications aux Sections 7 et 8, pp. 16–18.

⁵ Rao, C. B., "Advanced Statistical Methods in Biometric Research" (J. Wiley and Sons, Inc., New York, 1952).

⁶ Hughes, R. E., *J. Ecol.*, 37, 306 (1949), for soil analytical methods.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Horizon of the Steady-State Universe

In a reply¹ in *Nature* of February 26 to Mr. T. Gold, "The Writer of the Article" quotes statements by me² and by Mr. Gold that at first sight seem to contradict one another. Actually there is no contradiction, as I shall show.

First, a word about the 'time' used in cosmology. It was pointed out many years ago by Weyl that the world-lines of the galaxies seem to be distributed in space-time in such a way that a family of three-dimensional surfaces can be drawn orthogonal to them. In such a case, a time co-ordinate can be chosen so that the orthogonal surfaces are surfaces of constant time. With this choice, 'time' is equivalent to 'interval' measured along the world-lines of the galaxies (taken for simplicity to be point masses). This is the 'universal time' of all modern cosmologies, and this is the meaning to be attached to 'time' in this communication.

According to the geometry of the steady-state universe, space-time can be divided into two parts by a critical surface (not a surface of constant time). Our own world-line is entirely contained by one of the two regions. I shall refer to this region as being 'inside' the critical surface, and to the other region as lying 'outside'. A pulse of light from any event inside the critical surface can be detected by an observer using idealized instruments (that is, instruments that detect an infinitesimal amount of energy), the observer being stationed on our world-line and the observations being made in our past, present, or future, according to the particular event in question. In contrast, events occurring outside the critical surface are in principle unobservable, not only in the present but also over the whole of our world-line, past and future. The critical surface thus separates the events that are in principle observable from those events that are in principle unobservable. In my paper², the interior of the critical surface was called our observable universe, or simply the observable universe. In making this definition I placed 'observable universe' in inverted commas, as a precaution against the words being used away from their definition.

It may be noted that the corresponding critical surface for an observer in another galaxy is different from our critical surface, and the observable universe (according to my definition) is different too.

The world-lines of receding galaxies intersect our critical surface. Consider the world-line of one such galaxy. It intersects our critical surface at a particular time, t_0 say, and it does so in such a way that the past section of its world-line (times $t < t_0$) lies inside our observable universe—the future section lying outside. We may express this by saying that for $t < t_0$ the galaxy lies within the observable universe; but at t_0 it passes outside the observable universe. This explains what I meant² by saying that receding galaxies pass out of the observable universe (t_0 varies, of course, from one galaxy to another).

Now a pulse of light emitted by a particular galaxy at a time before t_0 does not reach us at the moment of emission, since a period of time

elapses while the light is travelling to us. This period depends on the moment of emission, and it does so in such a way as to tend to infinity as the moment of emission tends to t_0 . It follows, therefore, that even at a time $t > t_0$, we may still be detecting signals from the galaxy; but they must be from events that occurred before t_0 . Thus even though at time $t > t_0$ the galaxy lies outside the 'observable-universe', we may still be receiving signals from events that occurred before t_0 . This explains what Mr. Gold meant in his communication by saying that there is no last moment in our reception of signals from a galaxy, although there is a last moment, namely, t_0 , at which signals must start on their journey if they are ever to reach us.

It may be worth noting that to continue indefinitely receiving signals from a galaxy an observer must be equipped with idealized instruments. Peculiar situations would arise in everyday life if such instruments existed in actuality. It would be possible, for example, to observe the actions of a man long dead (trap light from events in the man's life inside a box with perfectly reflecting walls; then release as and when required).

A galaxy 'dies' so far as we are concerned at time t_0 , in the sense that its future cannot be observed by us. But we can still keep on observing events in the past history of the galaxy, because these events are 'bottled-up' in space-time to a degree that depends on the transit time of light.

F. HOYLE

St. John's College,
Cambridge.
March 15.

¹ *Nature*, 175, 382 (1955).

² *Mon. Not. Roy. Astro. Soc.*, 108, 372 (1948).

A Radio Survey of the Great Loop in Cygnus

DURING the past few years, intense radio sources have been identified with galactic nebulosities in Taurus¹ (the Crab Nebula), Cassiopeia², Puppis³, Gemini⁴ (I.C.443) and Auriga⁵. One of these five objects (I.C.443) bears a marked resemblance to the Great Loop in Cygnus, and it has been suggested⁴ that the latter may also be a radio source. The Loop comprises the well-known Network nebulae N.G.C. 6960 and N.G.C. 6992-5, together with several other patches of nebulosity. A rough sketch of the brighter parts of the system is shown in Fig. 1.

A radio survey of the Loop has been made with the 218-ft. fixed paraboloid at Jodrell Bank, operating at 92.5 Mc/s. At this frequency the paraboloid has a beam-width of about 3° between points of half-power. The results of the survey disclosed the existence of a radio source with the co-ordinates and intensity given in Table 1.

Table 1. DATA ON RADIO SOURCE (EPOCH 1950)

Right ascension	20h. 49m. 30s. $\pm$ 1m. 30s.
Declination	N. 29° 50' $\pm$ 1°
Intensity	$220 \pm 100 \times 10^{-26}$ watts m. ⁻² (c/s) ⁻¹ at 92.5 Mc/s.

The zenith angle of the source is about 23° at Jodrell Bank and it lies at the edge of the field of view of the large paraboloid. At these large zenith angles the elevation and shape of the beam are uncertain, and hence there may be considerable errors in the observed values of declination and intensity. However, in the present case it was possible to check

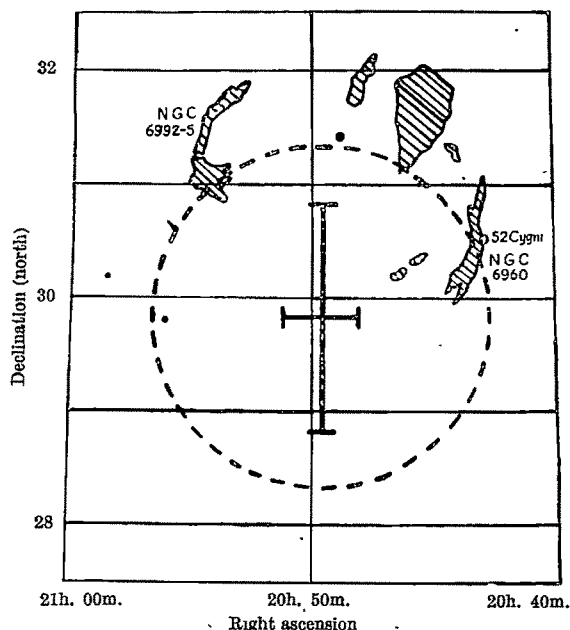


Fig. 1. A sketch of the more prominent nebulosities forming the Great Loop in Cygnus. The position and estimated limits of the centre of the radio source are shown by the cross (full line). The minimum angular diameter of the source is indicated by the circle (broken line).

the calibration of the aerial by observing a reference source of known position and intensity (private communication from M. Ryle) at approximately the same declination (N. $29^{\circ} 32.5'$) as the Loop. As a result of this check, the limits of error shown in Table 1 were established.

An examination of the records suggests that the angular diameter of the source lies in the range $3-6''$. Furthermore, this suggestion is strengthened by the fact that the source has not been reported in previous surveys made with interferometers of comparatively high resolving power.

The estimated limits of the position of the centre of the radio source have been plotted in Fig. 1, and it can be seen that it lies close to the Loop. If the nebulosities form part of a roughly spherical object, as photographs of the region indicate, then the position of the radio source probably lies within the outline of this object and towards the lower edge. The angular size of the source has been shown by a circle of diameter $3''$ and, since this is the minimum value given above, it is clear from the sketch that the angular size of the source is at least as great as that of the Loop.

On the basis of the evidence presented above, it is reasonable to conclude, but only tentatively, that the Loop in Cygnus is associated with the radio source. A more positive identification must await improved values for the declination and angular diameter of the source, and these can only be obtained from some other large instrument with a more favourable field of view.

The presence of this source close to the Loop is of considerable interest and indicates that this object may belong to the class of galactic nebulosities which are radio sources.

It also supports the suggestion that the Loop is similar to I.C.443 in Gemmi, and it is interesting to note that the intensity of the source given in Table 1 is comparable with that observed⁴ from I.C.443 (425×10^{-26} watts m^{-2} (c.s.)⁻¹ at 3.7 m.). Finally, a radio source in association with the Loop might provide an unrivalled opportunity for studying in detail the correlation between the radio emission and the visible structure of a nebulosity.

We thank Prof. A. C. B. Lovell for his interest in this investigation, and Prof. Z. Kopal for directing our attention to the problem in the course of a lecture given in 1953. One of us (D. W.) is indebted to the Department of Scientific and Industrial Research for a maintenance grant.

D. WALSH
R. HANBURY BROWN

Jodrell Bank Experimental Station,
Lower Withington,
Cheshire.
March 16.

¹ Bolton, J. G., Stanley, G. J., and Slee, O. B., *Nature*, 164, 101 (1949).

² Ryle, M., and Smith, F. G., *Nature*, 162, 462 (1948).

³ Baade, W., and Minkowski, R., *Astrophys. J.*, 119, 206 (1954).

⁴ Baldwin, J. E., and Dewhurst, D. W., *Nature*, 173, 164 (1954).

⁵ Hanbury Brown, R., Palmer, H. P., and Thompson, A. R., *Nature*, 173, 945 (1954).

Absorption of Underwater Sound by Substances in Process of Solution

In the course of work on the transmission of acoustic waves through aqueous solutions, we have noticed that solid substances in process of solution become extremely efficient absorbers of acoustic energy. In a typical experiment in which transmission was taking place at 400 kc./s. between transducers 1 ft. apart, the addition of 1 per cent by weight of common salt to the water produced attenuation of the order of 40 db., which was maintained until solution was complete. It was found that similar effects could be produced with all soluble solids, but not with liquids; and that although the amount of attenuation varied, it was in all cases high compared with that produced by insoluble substances.

Quantitative experiments, using a reverberation method which distinguishes absorption from scattering¹, were carried out with the results shown in Fig. 1. It will be seen that one part in 22,000 by weight of 'Analar' sodium chloride produced an attenuation thirty times as great as that normally

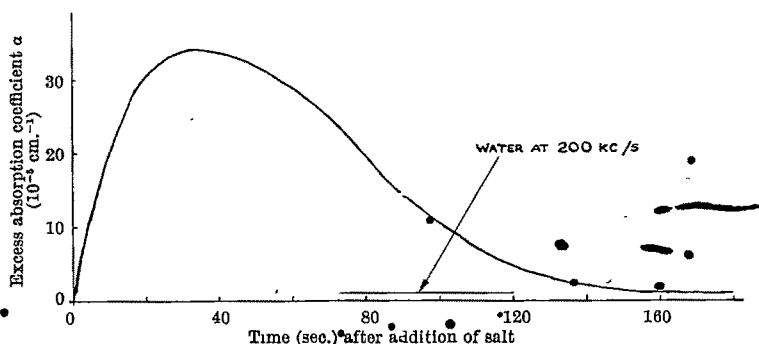


Fig. 1. Absorption of underwater sound by salt in process of solution. Addition of 0.1 gm. sodium chloride, grain size 211-252 μ , to 2.2 litres of water.

encountered in water at 200 kc./s. The maximum value of attenuation varied with frequency, being greatest at about 200 kc./s. for the samples used. The time between the addition of the salt and the attenuation reaching its maximum value appeared to be greatest near the same frequency.

The mechanism of this absorption was indicated by two experiments. In one, dissolving salt was illuminated transversely and studied in a microscope. Minute bubbles of gas could be seen leaving the crystals as they dissolved, and it was deduced that these were due to gas occluded in the crystal at the time of formation. In the second, salt was dissolved in water and recrystallized *in vacuo*, and it was found that the attenuating effect produced by the salt was much reduced. The absorption of sound by resonant gas bubbles has been described by several authors², and it has been shown theoretically that the diameter of the bubble is proportional to the wave-length of the sound. At 200 kc./s. the resonant diameter for air is 3×10^{-3} cm., so that the bubbles are invisible to the naked eye under normal conditions of illumination. The experimental results were consistent with the evolution of bubbles of this order of magnitude.

It has been stated that "a blanket of bubbles is a good absorber of high frequency waves when they traverse a liquid"², and the chief interest of the phenomenon described lies in the large attenuation produced by an extremely small quantity of air. It is probable that the average size of bubble depends on the method of preparation of the soluble particles. The method of introducing the bubbles appears to be novel and opens possibilities of good absorbers for use in experimental work.

R. D. C. REED

Department of Physics,
King's College,
Newcastle upon Tyne.

T. S. McLEOD

Cottage Laboratories, Ltd.,
Portsmouth Road,
Cobham, Surrey.

¹ Reed, R. D. C., Ph.D. thesis, University of Durham (1954).

² Richardson, E. G., "Ultrasonic Physics", 263 (Elsevier, 1952).

Application of Nuclear Coincidence Methods to Atomic Transitions in the Wave-length Range $\lambda\lambda$ 2000-6000 Å.

A RECENT communication by (the late) S. Heron, R. W. P. McWhirter and E. H. Rhoderick¹ on "Measurements of Life-times of Excited States of Atoms by the Method of Delayed Coincidences" was read with much interest here. Their method consists of exciting a source for 2×10^{-8} sec. and observing the intensity of the light emitted by the source at a given time after the excitation. Thus they observe the behaviour of a large assembly of atoms.

In this laboratory a different approach to the problem is made. A steady source is used and the light observed with two photomultipliers. By observing coincidences between photons emitted in a cascade transition and detected by the photo-

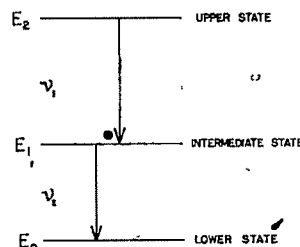


Fig. 1. Energy-level scheme

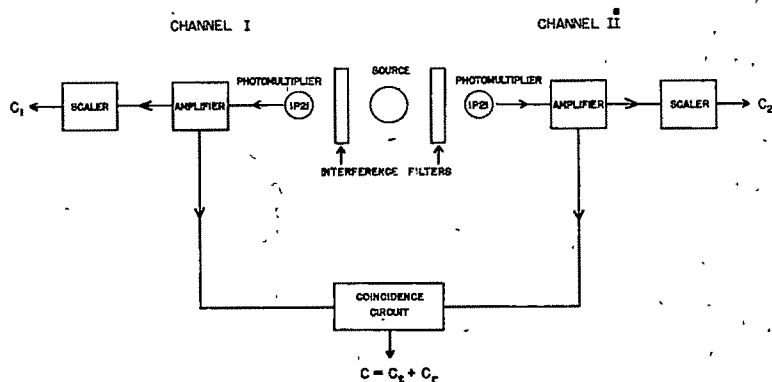


Fig. 2. Experimental arrangement

multipliers, the behaviour of individual atoms is observed. Since this application of nuclear coincidence techniques² has numerous potentialities not found in other methods, we feel it is of interest to comment on it briefly.

The method is illustrated by considering the simple energy-level scheme of Fig. 1. This may be assumed to apply to the atoms in the source, radiation from which is observed by two 1P21 photomultipliers arranged as in Fig. 2.

By means of appropriate interference filters, each photomultiplier is rendered sensitive to light of one frequency (the first to ν_1 , the second to ν_2). The pulses due to single photons from these cascade transitions are fed to standard coincidence circuits, and the total coincidence-rate C is recorded together with the single-channel rates C_1 and C_2 . The total coincidence-rate is composed of a 'true' coincidence-rate C_t (due to the simultaneous detection of photons emitted in cascade from the same atom), and a purely random coincidence-rate C_r (due to accidental coincidences of photons emitted by different atoms).

If we suppose N atoms per sec. enter the upper state E_2 and that the life-time of the intermediate state E_1 is much less than the resolving time 2τ of the coincidence circuit, then²

$$\begin{aligned} C_1 &= N\varepsilon_1 \\ C_2 &= N\varepsilon_2 \\ C_t &= N\varepsilon_1\varepsilon_2, \end{aligned} \quad (1)$$

where ε_1 , ε_2 are, respectively, the total efficiencies of channels I, II for the detection of photons of frequency ν_1 , ν_2 emitted by the source. The total efficiency is a product of the geometrical efficiency and the intrinsic efficiency of the detecting system. It should be emphasized that C_1 , C_2 and C are measured, and that C_t can be calculated from $C = C_t + C_r$ and $C_r = 2\tau C_1 C_2$. From the three equations (1) the absolute strength of source N and the efficiencies ε_1 and ε_2 can be deduced. This is

the first advantage of the nuclear coincidence method, namely, that it is a means of absolute calibration of the strength of a source.

A second advantage of this method is that one can determine directly whether the intermediate state is being populated or depopulated by a mechanism other than the radiative transitions observed, since true coincidences occur only between these two radiative transitions. If a fraction K of the atoms which enter state E_1 from E_0 by a radiative transition perform the radiative transition to E_0 , this appears in the true coincidence-rate as $C_i = KN\epsilon_1\epsilon_2$. Thus relative transition probabilities can be measured.

Finally, the life-time of the intermediate state can be measured³ by delaying the pulses from the channel observing the first transition, before feeding to the coincidence stage.

Experimentally it is necessary (a) to maintain a low strength of source (about $\frac{1}{2\pi}$) to keep C_i/C_r high,

and (b) to maintain ϵ_1 and ϵ_2 high by good geometry.

This direct application of nuclear coincidence techniques allows one to measure (1) absolute source strengths, (2) efficiency of the detection apparatus, (3) relative transition probabilities, (4) rates of mechanisms which populate an intermediate level, (5) life-times of intermediate states, and (6) angular correlations between the directions of emission of photons in cascade transitions.

Note added in proof. By this method the life-time of the 7^3S_1 state of mercury has been found to be $1.12 \pm 0.02 \times 10^{-8}$ sec. The upper transition arose from the ionization continuum and the lower transition was $7^3S_1 \rightarrow 6^3P_1$ (λ 4358.34 Å.).

This work is being carried out as part of a project sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, under Contract AF 19(122)-470.

ERIC BRANNEN
F. R. HUNT
R. H. ADLINGTON
R. W. NICHOLLS

Department of Physics,
University of Western Ontario,
London, Ontario. Nov. 1.

¹ Heron (the late), S., McWhirter, R. W. P., and Rhoderick, E. H., *Nature*, **174**, 564 (1954).

² Dunworth, J. V., *Rev. Sci. Instr.*, **11**, 167 (1940).

³ Bell, R. E., Graham, R. L., and Petch, R. E., *Can. J. Phys.*, **30**, 35 (1952).

⁴ Birks, J. B., and Wright, G. T., *Proc. Phys. Soc.*, B, **67**, 657 (1954).

Small-Angle X-Ray Diffraction Patterns of Collagen

In the investigation briefly reported here, the collagen fibres used were from beef achilles tendon. The diffraction patterns were obtained with an evacuated camera and a rotating anode X-ray tube having a copper or chromium target. The results discussed refer only to copper $K\alpha$ radiation; the chromium target was used solely for confirming intensity measurements. The observations on dry collagen were made with vacuum-dried fibres which remained *in vacuo* throughout the experiments, whereas wet fibres were mounted in a cell with beryllium windows and remained in a saturated atmosphere for the duration of the exposure. Photographs were obtained from which measurements were made of the intensities of twenty-five orders in the pattern for wet fibres, and twenty-three orders in the case of dry

fibres. Exposure times involved may be indicated by giving the times required to give an intensity in the first order of $D = 1.0$ above the background. For dry achilles tendon this time was 2.5–3 hr., whereas for wet fibres the time was about thirty minutes, the apparatus running under identical conditions with the tube operated at 30 kV., 80 m.amp. The long spacing d of the dry fibres was 635 Å. and for the wet fibres 670 Å.

A particularly interesting feature of the diffraction patterns was the appearance of relatively strong reflexions at the nineteenth and twentieth orders for dry fibres and at the twentieth and twenty-first orders for wet fibres. These results are set out in Table 1, in which the intensity scale is such that the first-order intensity is 1,000.

Table 1

Order n	Dry fibres		Wet fibres	
	Intensities	d/n	Intensities	d/n
18	7	35.2	1	37.2
19	10	33.4	0.5	35.2
20	10	31.8	5	33.6
21	7	30.2	4	31.9
22	4	28.8	2	30.4

It may be remarked that the nineteenth to twenty-first orders were well resolved, and there is no indication that the enhancement of the intensities is due to superposition on a diffuse line covering the two adjacent orders of the small-angle pattern. Apparently the Fourier transform of the electron density distribution along both wet and dry fibres has a pronounced maximum corresponding to a spacing of 31–34 Å., centred approximately on 32.8 Å. There is therefore a suggestion that, although the long spacing of collagen may vary considerably, there is nevertheless a constant structural unit of about 32.8 Å. in length.

Some attempts have been made to label specific amino-acids with heavy atoms and to observe the resulting small-angle diffraction patterns. According to Grassmann and Eusch¹, histidine combines with silver when collagen fibres are treated with silver nitrate, and with lead when treated with lead acetate. We found that the silver treatment considerably modified the small-angle pattern, but the lead treatment had no effect. On the other hand, the wide-angle pattern is not affected by silver, but shows rings which may be attributed to the deposition of granules of lead acetate on the fibres. It appears that silver does in fact enter into chemical combination with the protein, but not lead. Treatment with iodine dissolved in potassium iodide solution, which may be expected to result in attachment of iodine to tyrosine, has also been found to modify considerably the small-angle pattern. Patterson functions are being calculated for the different patterns observed; but so far it appears that silver is not a sufficiently heavy atom to show up clearly in the Patterson plot.

A full account of this work will appear in due course when observations on kangaroo tail tendon fibres have been completed.

C. R. WORTHINGTON
S. G. TOMLIN

Department of Physics,
University of Adelaide,
South Australia.

¹ Grassmann, W., and Kusch, D., *Hoppe-Seyler's Z. physiol. Chem.*, **290**, 216 (1952).

Derivatives of Caffeic Acid in Sweet Potato attacked by Black Rot

SEVERAL polyphenols have been found to be accumulated in the sound part next to the injured tissues of sweet potato attacked by black rot caused by *Ceratostomella fimbriata*, and chlorogenic acid, caffeic acid and isochlorogenic acid have been isolated as well as the two kinds of new caffeic acid derivatives. Previously, G. O. Rudkin and J. M. Nelson¹ had isolated chlorogenic acid and a group of components giving caffeic acid by alkaline hydrolysis from sound sweet potato.

Extraction and fractionation of the material were carried out chiefly by the method of Rudkin and Nelson. Sound tissues taken from sweet potato suffering from black rot were extracted with acetone, polyphenols in the extract were converted to the lead salts, which were decomposed with dilute sulphuric acid, and the resulting solution was shaken with ethyl acetate; from the ethyl acetate layer (upper) crude polyphenols were separated. These crude polyphenols were dissolved in phosphate buffer (pH 4.7) and shaken with an equal volume of ethyl acetate; the buffer layer (lower) was adjusted to pH 2.0 and shaken with ethyl acetate, the ethyl acetate was concentrated and the crystalline chlorogenic acid (m.p. 205–6°) was obtained by adding chloroform to it.

The remainder of the ethyl acetate layer, separated from the buffer layer, was concentrated, and, by adding petroleum ether gradually, polyphenols in this layer were divided into two parts, which were quickly precipitated and slowly precipitated respectively. From the latter caffeic acid (m.p. 192–94°) was removed as crystals. The former was subjected to 44-transfer counter-current distribution using phosphate buffer (pH 5.8) and ethyl acetate as solvents. As the result, it was divided into three fractions, A, B, C, having partition coefficients 0.48, 1.36 and greater than 40 respectively. A and B were collected and again subjected to counter-current distribution. They gave curves corresponding with the theoretical curve, proving their freedom from impurity; but they have not been crystallized in the free form and derivatives have not been prepared. It is not known whether C, a white powder, is a single polyphenol or not.

A, B and C were decomposed with alkali, and separated in crystals into caffeic acid (yield 100 per cent each) and quinic acid (60 per cent each). Each caffeic acid was identified by mixed melting point (192–94°) and elementary analysis, further confirmed by those of methyl caffeate derived from it. Each quinic acid was also identified by mixed melting point (168–69°) and elementary analysis of its brucine salt.

The ultra-violet absorption spectra of A, B and C were almost the same as that of chlorogenic acid. Infra-red absorption spectra of A and B were very similar, but they were different from that of chlorogenic acid, while that of C was not like either of them. The optical rotations of A, B and C were $[\alpha]_D^{25} - 155^\circ$, $[\alpha]_D^{25} - 196^\circ$, and $[\alpha]_D^{25} - 94^\circ$; and the neutral equivalents of A and B were 586 and 563 respectively; C had a large value and seemed a polymer. The properties of B were similar to those of isochlorogenic acid ($[\alpha]_D^{25} - 230^\circ$, neutral equivalent c. 580, rate of oxidation by periodic acid, etc.) isolated from coffee beans and investigated by H. M. Barnes and W. V. White². We also attempted to separate isochlorogenic acid from coffee according to

the method of Barnes and White, and the acid was subjected to counter-current distribution; the distribution curve was in accordance with that of B. Thus B was identified as isochlorogenic acid. The lower rotation value of B compared with Barnes's might be due either to the different conditions of measurement (rotation was measured at 1 per cent concentration in alcohol solution using a 1-decimetre tube) or to traces of impurity. We have been informed by J. Corse (private communication) that he has isolated isochlorogenic acid from dehydrated sweet potato.

The properties of A and B are very alike, except for different values in the rotation, partition coefficient, and solubility in ethyl acetate. A was found to be present with B in the black-rot tissue of sweet potato; but it might be derived from B or some other component during isolation. Tentatively, we propose to call A pseudochlorogenic acid. We are considering the position of linkage of the caffeic acid with quinic acid. We could obtain no evidence for the presence in the sound part next to the injured tissues of sweet potato of neochlorogenic acid recently isolated by J. Corse³ from peaches.

We thank Prof. Y. Sumiki and Prof. S. Funahashi, of Tokyo University, and Dr. William V. White, of the General Food Corporation, U.S.A., for their advice, and Dr. J. Corse, of the U.S. Agricultural Research Service, for information and a present of neochlorogenic acid.

IKUZO URITANI
MASATERU MIYANO

Laboratory of Biochemistry,
Faculty of Agriculture,
Nagoya University,
Anjo, Japan.
Dec. 8.

¹ Rudkin, G. O., and Nelson, J. M., *J. Amer. Chem. Soc.*, **69**, 1470 (1947).

² Barnes, H. M., and White, W. V., *J. Amer. Chem. Soc.*, **72**, 4178 (1950).

³ Corse, J., *Nature*, **172**, 772 (1953).

Development of Anopheles A Virus in the Endoplasmic Reticulum of Ehrlich Ascites Tumour Cells

EHRLICH ascites tumour grown as a free cell suspension in the abdominal cavity of mice was inoculated with a mosquito-borne virus, anopheles A^{1,2}, usually propagated in the brain tissue of mice. Some destruction of tumour cells occurred within 5–6 days.

Particles believed to be the virus were identified within tumour cells by electron microscopic examination of ultra-thin sections. As in the case of other viruses studied in thin section^{3–5}, this virus also shows internal structure, here consisting of a transparent ~30 mμ core, and a compound electron-opaque shell, ~12 mμ thick, giving a total diameter of approximately 55 mμ. (Although the size of anopheles A virus has been reported to be larger than 55 mμ⁶, recent studies with ionizing radiation by E. Pollard and R. A. Brown indicate a particle-size considerably smaller than that determined by ultrafiltration.) Detailed study of viral foci in serial sections showed them to be localized within what has been variously referred to as the endoplasmic reticulum⁷, ergasto-

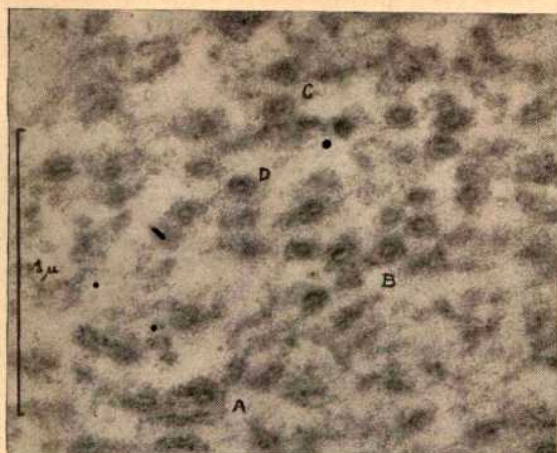


Fig. 1. Particles can be distinguished as embedded in portions of endoplasmic reticulum, as at A and B, and their linear arrangement can be followed as indicated at C and D. ($\times 37,200$)

plasm⁸ or intracytoplasmic membranes⁹. In Ehrlich ascites tumour cells such a system exists in the form of an interconnecting, primarily canalicular structure best classified as endoplasmic reticulum; virus particles are harboured within its components (Fig. 1), and are not found elsewhere. The localization of the viral particles can be traced in the serial micrographs of Fig. 2. The density of the virus population in any part of the cell varies not only with the number of particles embedded in the particular portion of the endoplasmic reticulum, but also with the degree of organization and closeness of the meshwork in that region, which appears to be intricate and highly flexible. Extensive examination of tumour cells from non-inoculated mice has failed to reveal any particles of comparable structure. Further work is in progress and will be reported in more detail elsewhere.

It is of interest to note that all viruses adequately studied thus far have been shown to possess a complex and characteristic internal structure; moreover, as illustrated by herpes simplex, influenza and the pox viruses³⁻⁵, they may differ widely in the location and mode of development in the cell. Anopheles A virus is the first viral agent, however, which has been shown to be intimately associated with the endoplasmic reticulum.

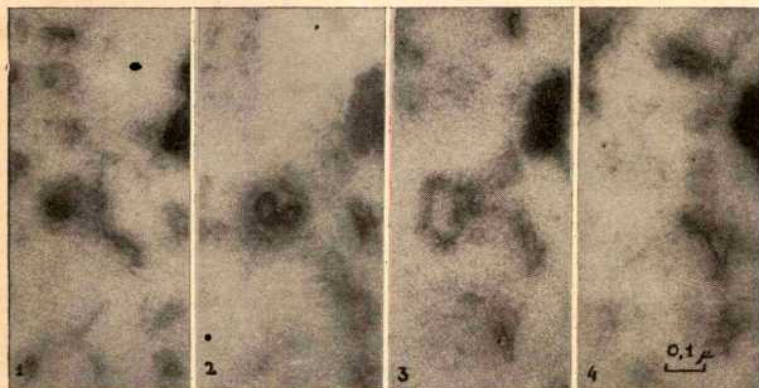


Fig. 2. Four serial sections illustrating: (1) the first intimation of a possible viral particle, surrounded by characteristic cytoplasmic granules, so frequently associated with the endoplasmic reticulum; (2) the appearance of two particles within a membranous sac, with vesicles of endoplasmic reticulum in the vicinity; (3) the distinct vesicular remnant, now devoid of particles; (4) disappearance of portion previously considered but emergence of other branches of endoplasmic reticulum. ($\times 54,000$)

The work was supported by the Research Division, American Cyanamid Company, Pearl River, New York; the Lillia Babbitt Hyde Foundation; and the Damon Runyon Memorial Fund.

MARLENE FRIEDLAENDER
DAN H. MOORE
ROBERT LOVE
RAY A. BROWN
HILARY KOPROWSKI

Department of Microbiology,
Columbia University;

College of Physicians and Surgeons; and
The Viral and Rickettsial Research Section,
Research Division of American Cyanamid Co.,
Pearl River, New York.

¹ Roca-Garcia, M., *J. Inf. Dis.*, **75**, 160 (1944).

² Koprowski, H., and Lowe, R., *Proc. Amer. Assoc. Cancer Res.*, **1**, 26 (1954).

³ Gaylord, jun., W. H., and Melnick, J. L., *J. Exp. Med.*, **98**, 157 (1953).

⁴ Morgan, C., Ellison, S. A., Rose, H. M., and Moore, D. H., *J. Exp. Med.*, **100**, 195 (1954).

⁵ Morgan, C., Ellison, S. A., Rose, H. M., and Moore, D. H., *J. Exp. Med.*, **100**, 301 (1954).

⁶ Smithburn, K. C., and Bugher, J. C., *J. Bacteriol.*, **66**, 173 (1953).

⁷ Palade, G. E., and Porter, K. R., *Anat. Rec.*, **112**, 370 (1952).

⁸ Oberling, W., Bernham, W., Gautier, A., and Hagenau, F., *La Presse Médical*, 61e Année, 719 (1953).

⁹ Sjöstrand, F. S., and Ehodin, J., *J. Exp. Cell Res.*, **4**, 426 (1953).

Sequence of Sexual and Asexual Phases in *Antithamnion spirographidis* Schiffner

THE plants of many Florideae bear either sexual reproductive organs or tetrasporangia, and there is a reasonable amount of cytological evidence in support of the generalization that plants bearing tetrasporangia have twice as many chromosomes as those bearing sexual organs, meiosis occurring in the tetrasporangium. On the other hand, there is surprisingly little evidence from controlled experiments to show that the plants which develop from carpospores bear tetrasporangia and that those which grow from tetraspores bear sexual organs. Lewis¹ allowed either tetraspores or carpospores, whichever were available, to become attached to oyster shells in the laboratory and he then submerged the shells in the sea. From subsequent examination of the shells, he concluded that tetraspore-bearing plants of *Polysiphonia violacea* had developed from carpospores and sexual plants from tetraspores of *Griffithsia bernetiana* and *Dasya elegans*. The numbers of plants grown were *Polysiphonia violacea* (6), *Griffithsia bernetiana* (60) and *Dasya elegans* (149). Dammann² obtained small plants bearing tetrasporangia of *Halarachnion ligulatum* from carpospores, although tetrasporophytes of this species are unknown in the sea. Hassinger's³ experiments with *Callithamnion colymbosum* were more extensive; but the results were complicated by the fact that in this species some diploid plants bear branches with male and female reproductive organs as well as tetrasporangia.

Since the existing evidence is so limited it seems worth recording the results of a preliminary experiment, which it is not likely will be further elaborated at present, and which demonstrates the

sequence of sexual and asexual phases in the case of *Antithamnion spirographidis* Schiffner. This alga is a native of the Mediterranean but has also been reported from Plymouth by Westbrook⁴. It appears to grow comparatively well in marine aquaria, and the material used in this experiment came from an aquarium in the Zoology Department of this University. My thanks for it are due to Prof. H. Graham Cannon.

Tetraspores were liberated from two plants at the end of October 1954, and the development of plants from nine of these has been followed. After liberation of a few tetraspores, the parent filaments were quickly removed, as minute fragments are capable of rapid attachment by the production of rhizoids and of subsequent development into new individuals. At the end of the month, nine germlings were moved to individual culture dishes, the transfer causing a temporary slowing down in growth. However, by January 12, 1955, spermatangia were to be seen on four plants and procarps on a fifth. Spermatangia were abundant on two of the four male plants. By February 1 procarps could be seen on the remaining four plants. This development of spermatangia on four plants and procarps on five suggests the existence of sex chromosomes and segregation at meiosis in the tetrasporangium; but on February 1 spermatangia were to be seen on the plant on which procarps were found on January 12 and in addition an immature carposporophyte. By February 18 there were numerous mature carposporophytes on this plant. The occurrence of both male and female reproductive organs on one plant indicates the need of a much more extensive experiment. In addition, a few cells resembling tetrasporangium mother-cells were seen on one of the female plants but never any mature tetrasporangia.

Carpospores of *A. spirographidis* were germinated in October 1952 and the resulting plants kept together in one culture dish. By February 1953, numerous tetrasporangia had developed on them. These plants were not grown under the same conditions as the plants raised from tetraspores and so comparison with the time taken for the development of sexual reproductive organs is of no value.

While the numbers of plants involved in this preliminary work is small, the evidence so far as it goes shows that tetrasporophytes develop from carpospores and sexual plants from tetraspores. This appears to be the first record of the development of plants from both tetraspores and carpospores of the same species to maturity and reproduction. It has also shown that carposporophytes develop in less than eighteen days. The preliminary nature of this work must be emphasized, however.

KATHLEEN M. DREW

Department of Cryptogamic Botany,
University, Manchester. March 15.

¹ Lewis, I. F., *Bot. Gaz.*, 53, 236 (1912).

² Dammann, H., *Wiss. Meeresuntersuch.*, 18, 26 (1930).

³ In Hartmann, M., "Die Sexualität" (Jena, 1943).

⁴ Westbrook, M. A., *J. Bot.*, 72, 65 (1934).

Juvenility Phenomena associated with Crown Gall

In a review of juvenility phenomena, Allsopp¹ recently emphasized the close apparent connexion between nutrition and the development of juvenile leaf-forms. In this Department the factors affecting regeneration of plants from roots are the subject of a general study², in the course of which juvenile characters have been observed on young root suckers produced by several species. These will be described in detail elsewhere, but it may be of interest to refer to a special case which has occurred.

When adventitious shoots grow from root cuttings of raspberries (*Rubus idaeus* L.), the earliest leaves are usually of pronounced juvenile form, especially when they grow (a) from thin roots³, or (b) from small pieces of root, or (c) from pieces of dying root, or (d) at high temperatures. In shoots which continue to develop, successive leaves become progressively more adult in form, first deeply lobed and later compound (Fig. 1, plant A).

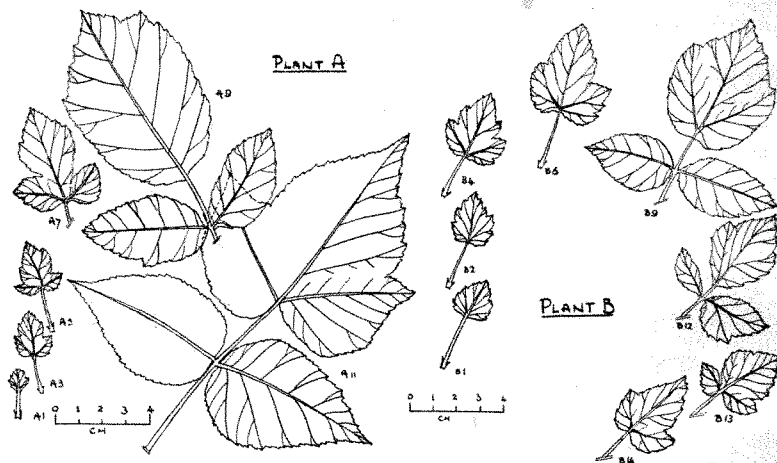


Fig. 1. Form of successive leaves on young Lloyd George raspberry root suckers. Plant A, normal; plant B, affected by crown gall. Leaves are numbered serially from ground-level towards the apex

However, a few cases have been observed in which the earliest leaves followed the normal sequence, but where the sequence was later reversed, leaves reverting to more juvenile forms (Fig. 1, plant B). These plants were examined and in each case were found to bear well-developed basal galls, caused by *Bacterium tumefaciens* E. F. Sm. and Towns. In a large number of plants examined, all shoots reverting to the juvenile form were found to have massive galls, which suggests that juvenility was induced by the effect of the galls.

The plants illustrated were grown in a heated glasshouse and were comparable in age and cultural history.

J. P. HUDSON
I. H. WILLIAMS

Department of Horticulture,
University of Nottingham School of Agriculture,
Sutton Bonington.
Dec. 28.

¹ Allsopp, A., *Nature*, 173, 1032 (1954).

² Hudson, J. P., *Nature*, 172, 411 (1953).

³ Hudson, J. P., *J. Hort. Sci.*, 29, 27 (1954).

Cellulase and Chitinase in Soil *Amoebæ*

It has long been known that cellulose and chitin are broken down by many species of both bacteria and fungi that can be isolated from soil. It is probable that the soil fauna may also be important in this respect, for it is known that earthworms and eelworms may possess both cellulase and chitinase¹. Some soil amoebæ were examined to see whether they, too, possessed these enzymes.

'Pure mixed' cultures (a single species of amoeba feeding on a single species of bacteria) of three species of soil amoebæ² grown on non-nutrient agar were harvested, ground between the surfaces of a standard ground-glass joint and incubated with toluene overnight. The extracts were centrifuged and the supernatants examined for the presence of cellulase and chitinase. The bacteria used as food were soil organisms that had been shown to produce neither of the enzymes when grown under similar conditions in the absence of amoebæ. Cellulase activity was detected by following the production of reducing sugar from a solution of sodium carboxymethylcellulose at pH 5, or from a suspension of finely divided cellulose precipitated by dilution of a cellulose dispersal in syrupy phosphoric acid. Chitinase activity was detected by following the production of acetylglucosamine from a suspension of finely divided *Septia* chitin prepared by dilution of a dispersal in concentrated hydrochloric acid. Very little reducing sugar and no acetylglucosamine were formed on incubating the extracts in the absence of substrate.

The results of an experiment in which sodium carboxymethylcellulose was the substrate are shown in Table 1 (the figures for formation of reducing sugar have been corrected by subtraction of the values for appropriate controls). Action of *Helix* cellulase on this substrate stops when 37 per cent of the substrate weight has appeared as reducing sugar calculated in terms of glucose. The figure for grams reducing sugar produced per gram of total nitrogen in the extract was calculated as a means of comparing the extracts among themselves and with the digestive enzymes of *Helix aspersa*. Under similar conditions, this figure for pooled digestive juice of the snail is about 50 gm. reducing sugar per gm. total snail nitrogen, or at least fifteen times as great as the figure for the amoebæ. The figure for the amoebæ may be expected to be low for the following reasons. All the amoebæ were not in the same state of activity, a considerable proportion having begun to encyst; some of the total nitrogen of the harvested material was derived from uneaten bacteria or waste products; and the cellulase of the amoebæ may have been inactivated by dilution and mixing of the enzyme with other components of the organisms (the digestive juice of the snail was removed from the digestive tract and not diluted with the components of the remaining tissues). It is possible, therefore, that the amoebæ may, in terms of activity per gram total nitrogen, have a cellulose-decomposing power of the same order as that of the snail. The extracts were also shown to hydrolyse finely divided cellulose. No increase in the rate of hydrolysis using this substrate was found when 60 µgm. bovine serum albumin per ml. was added to the assay medium—presumably sufficient protein was already present in the medium to swamp any effect of added protein³. The maximum dry weight of amoebæ present in each assay varied from 1 to 5 mgm.

Table 1

Food organism	Amoeba	Reducing sugar formed (calc. as glucose) as % carboxymethylcellulose after 13 days incubation	Reducing sugar (gm.) formed per gm. total nitrogen of extract, 5 days
<i>Aerobacter</i> sp.	<i>Hartmannella glabra</i>	8	2.5
" "	<i>Hartmannella</i> sp.	17	3.6
" "	<i>Schizoscyrenus erythraeus</i>	9.5	1.0
Soil organism (4002)	<i>Hartmannella</i> sp.	19.3	3.1
" "	<i>Schizoscyrenus erythraeus</i>	20	1.8

Incubation of finely divided chitin for 17 days at 35° at pH 5 with amounts of extract similar to those used when cellulose was the substrate resulted in the decomposition of 30–130 µgm. of chitin. These amounts were about one-fifth of the weight of cellulose broken down under similar conditions.

The amoebæ described are the only soil protozoa that have been shown to possess cellulase and chitinase; but the cellulose-decomposing abilities of ciliates in the ruminaant and termite are well known, and it is probable that many other genera of soil protozoa may be active. It would also be of interest to examine some representative mites from this point of view.

I wish to thank Dr. B. N. Singh, without whom this work would have been impossible, and Mr. T. I. Steenson, of the Microbiology Department at Rothamsted, who were each kind enough to supply the cultures used in the experiments described.

M. V. TRACEY

Rothamsted Experimental Station,
Harpenden,
Herts.
Jan. 20.

¹ Tracey, M. V., *Nature*, **177**, 776 (1951); 2nd Int. Cong. Biochem., Paris, Résumés des Comm. 242 (1952).

² Singh, B. N., *Phil. Trans. Roy. Soc.*, B, **236**, 405 (1952).

³ Whittaker, D. R., *Science*, **116**, 90 (1952). Tracey, M. V., *Biochem. Soc. Symposia*, **11**, 49 (1953).

Extraction of Enchytraeid Worms from a Coniferous Forest Soil

THE ecology of the terrestrial Enchytraeidae has been neglected mainly because of the lack of an adequate technique for assessing population size and partly because of taxonomic difficulties. Recently, Overgaard Nielsen¹ has described a method for the large-scale extraction of these worms from soil. This consists of heating soil cores in an earthenware cylinder over a water-bath, and driving the worms upwards into a layer of cooled sand on top of the soil. The enchytraeids are then recovered by washing from the sand.

Studying the enchytraeid population of a coniferous forest soil, this method was not found to be satisfactory, despite attention to detail. Too many dead worms were found in the core, particularly in the litter layer. Therefore an attempt was made to improve on the alternative technique mentioned by Nielsen, in which heat is applied from above to soil spread out on a sieve resting in a funnel full of water. The worms present move downwards through the sieve into the funnel and can be drawn off. This technique was developed, using soil cores from a pure

stand of Douglas fir near Bangor, Caernarvonshire. Their profile shows a natural division into litter, humus and soil layers. Cores of 6.3 cm. diameter and 6.0 cm. depth were taken and subdivided into these layers before extraction. This reduced the bulk of soil in each extractor and provided data on stratification of the worm population. Samples were taken using a corer split longitudinally so that it could be opened and the core subdivided without forcing it out of the corer; this minimizes risk of damaging organisms by compression.

The two methods were compared using material from the above site, ten pairs of soil cores being taken side by side. One of each pair of cores was extracted by the Nielsen method, the other by the wet-funnel method. The litter layer was excluded from the comparison because of its lack of uniformity, and because the worms seemed to find difficulty in traversing the loosely packed litter in Nielsen's type of extractor. In the wet-funnel method the humus was treated as a single sub-sample, and the soil layer was subdivided into two 2-cm. sub-samples; in the other method, the core was treated as a unit. For each of the ten pairs the wet-funnel method gave the higher value, and the average figures were 107.8 (S.D. $\pm$ 64.7 coeff. var. 60 per cent) for the Nielsen method and 313.9 (S.D. $\pm$ 176.4 coeff. var. 56 per cent) for the wet-funnel method. Even if the worms are not randomly dispersed, such a contrast seems to point to a greater efficiency for the former method. A 't' test shows the means to be significantly different ($t = 3.29$, $P < 0.01$).

On the evidence from the pilot experiment, an apparatus has been designed to deal with large-scale routine extractions. Each extraction unit consists of an 11-cm. diameter funnel resting in a 9-cm. hole in an asbestos board. A 9-cm. wire-gauze sieve of 30 meshes to the inch rests in the funnel. The bottom of the funnel is closed by a screw clip on a piece of rubber tubing. Heat is supplied from a 60-watt electric light bulb enclosed in a light metal cylinder of 11 cm. diameter and 18 cm. height. The bottom of the cylinder is 1½ cm. from the top of the funnel. Twenty-four such units are wired in parallel, and the heating is controlled by means of a variable resistance. The intensity is increased gradually so that the surface reaches a temperature of approximately 45° C. after 150 min., when extraction is complete. Then the worms are run out from the bottom of the funnel for counting and identification.

The reason for the greater efficiency of the wet-funnel method is obscure. The personal element, the depth of soil to be traversed, and the type of soil may be factors. Nielsen's comparative lack of success with the wet-funnel method is surprising. He used a much larger apparatus—420 c.c. of soil extracted on a single sieve of 35 cm. diameter—and sample material from a *Brachypodium* grassland. The wet-funnel method is convenient because extraction is a single process, and heat control is easy. It seems well suited to a coniferous soil lacking ground vegetation, but its suitability for other types has not been examined.

The wet-funnel method has been used weekly over the past six months. During this period population densities, based on the mean of ten samples, ranged from 11.2 (coeff. var. 45.6 per cent) to 25.7 (coeff. var. 67 per cent) per sq. cm. The maximum density of more than a quarter of a million per square metre is much higher than any previously recorded for a comparable habitat. Short-term fluctuations of the

population occur; but the cause of these is not yet known. Examination of vertical distribution indicates that 90 per cent of the worms occur in the top 6 cm. of the profile, 79 per cent of these in the humus layer. This distribution is not only quantitative but also qualitative, and different species of enchytraeid dominate the various layers of the profile. Five types of worm have been noted so far; but identification is not yet complete.

I am indebted to Dr. T. B. Reynoldson for his interest in the problem. The work is being financed by a research grant from the Department of Scientific and Industrial Research.

F. B. O'CONNOR

Department of Zoology,
University College of North Wales,
Bangor, Caernarvonshire.
Jan. 18.

¹ Nielsen, C. Overgaard, *Oikos*, 4, 11 (1952-53).

Pumilin, a New Antibiotic from *Bacillus pumilus*

ALTHOUGH it had been observed that strains of *Bacillus pumilus* produce substances with antibacterial activity, very little work has been done to isolate these substances. Gilliver¹ observed the antibacterial activity of strains of *B. pumilus*, but made no attempt to isolate the active principles. Dvornik and Benedict² isolated an antibacterial agent from a strain of *B. pumilus* which they showed to be similar to subtenolin, an antibiotic from *B. subtilis*. Borowski and others³ obtained an antibiotic, tetaine, from a strain of *B. pumilus*.

Pumilin is produced by a strain of *B. pumilus* isolated from a sample of soil collected by Dr. R. K. Callow, of this Institute, in northern Nigeria during an expedition organized by the Medical Research Council for the survey of medicinal plants in 1949-50.

The antibiotic is obtained in good yield from a 24-hr. aerated submerged culture in a simple synthetic medium containing ammonium citrate or phosphate as a source of nitrogen, and glucose, glycerol or cane sugar as a source of carbon. Several successful batches of about 60 gallons each were fermented in a 100-gallon tank at the Medical Research Council's Antibiotic Research Station in Clevedon, Somerset.

The broth, after adjusting to pH 7, was autoclaved at 15 lb. for 25 min., cooled, and ammonium sulphate (40 per cent w/v) added. After settling for a few hours, the precipitate was decanted off from the clear liquid layer and extracted with ethanol. Ethanol was removed under reduced pressure, and the dry material obtained was extracted several times with acetone. Acetone was evaporated off and the residue extracted with benzene, which removed an oil and two inactive crystalline compounds of melting point 117.5° and 120°. The insoluble part in benzene was extracted with 2 per cent sodium bicarbonate solution for three days in the cold room and the precipitate was separated and repeatedly extracted with small quantities of absolute alcohol. The alcohol-insoluble fraction was dissolved in 85 per cent acetone and passed through a column of alumina which adsorbed a dark brown impurity. The effluent was evaporated to dryness and the yellowish product obtained was extracted with very small quantities of 85 per cent

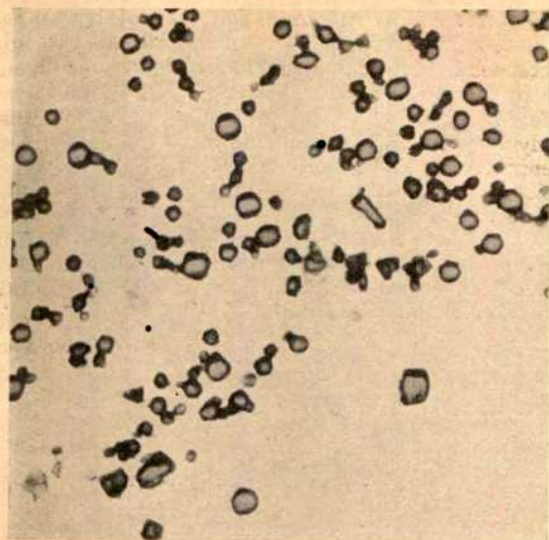


Fig. 1. Crystals of pumilin. ($\times 200$)

acetone, which removed a more soluble brown impurity, leaving pumilin as a lemon-yellow compound. About 700 mgm. were obtained from 500 gallons of broth.

Pumilin crystallizes from *n*-butanol as small hexagonal crystals with average diameter of 10μ (Fig. 1). It does not melt below 360°C . It is sparingly soluble in warm methanol and ethanol, slightly more soluble in aqueous acetone (85 per cent; 1 mgm./ml.) and soluble in pyridine, collidine and morpholine. Its solution fluoresces strongly in ultra-violet light and rapidly loses activity in ultra-violet light and sunlight, and more slowly in diffused light with a decrease in fluorescence. It does not diffuse through agar even in the presence of detergents, and hence cannot be assayed by diffusion methods. It dissolves in $N/20$ sodium hydroxide solution without loss of activity. The infra-red spectrum shows the presence of a hydroxyl group; but it gives no colour with ferric chloride. In $5N$ hydrochloric acid at room temperature it quickly turns a copper-red with slight decrease in the activity, the change of colour being irreversible. It is antagonized *in vitro* by horse serum, and it is also inactivated slowly in nutrient broth at 37°C . It is unaffected by cysteine.

Pumilin is active against Gram-positive organisms only. *In vitro* activities of pumilin and penicillin (sodium salt, 1,650 u./mgm.) against a few organisms are shown in Table 1.

Table 1

	Inhibition dilution ($\times 10^4$)			
	<i>S. aureus</i>	<i>Str. haemolyticus</i>	<i>Sir. faecalis</i>	<i>P. septica</i>
Pumilin	400-500	400-500	50-125	20
Penicillin (sodium salt)	50-80	150-300	<1	<1

Pumilin is highly toxic to white mice when given as a suspension by the intraperitoneal route (MLD, 750 $\mu\text{gm./kgm.}$). The tolerated dose by the subcutaneous route is, however, much higher (MTD, 50 mgm./kgm.). It fails to protect white mice infected with *Str. haemolyticus* when treated with tolerated doses by either route.

Pumilin contains about 1.5 per cent nitrogen. When chromatographed on paper with butanol/acetic acid as the solvent, it gives no spots with ninhydrin; but the hydrolysate obtained with $5N$ hydrochloric acid gives seven ninhydrin-positive spots.

Most of the antibiotics of bacterial origin are polypeptides, but the molecule of pumilin seems to be largely non-peptide in nature.

Details of this work will be published elsewhere. I thank Dr. A. T. Fuller for his interest in this work and for carrying out the animal experiments.

D. S. BHATE

National Institute for Medical Research,
London, N.W.7.

Jan. 10.

¹ Gilliver K., *Brit. J. Exp. Path.*, 30, 214 (1949).

² Dvoneh, W., and Benedict, R. G., *Antibiotics and Chemotherapy*, 3, 192 (1953).

³ Borowski, E., et al., *Chem. Abstracts*, 47, 7,594 (1953); 48, 11,000 (1954).

Location and Innervation of the Corpus Cardiacum in the Larvæ of some Calliphorinae (Diptera)

THE retrocerebral endocrine organs of the third instar larvæ of *Calliphora erythrocephala* Mg., *Calliphora vomitoria* Linn., *Lucilia sericata* Mg., *Lucilia caesar* Linn., and *Protophormia terrae-novae* R-D. have been examined, by direct dissection with methylene blue supravital staining and in serial sections, in order to elucidate a number of hitherto obscure points. Descriptions of these organs in *C. erythrocephala* are given by Thomsen¹ and by Possompes² but disagree in some details. The latter's term 'peritracheal glands' for the large cell component of the ring of Weismann³ has been adopted here.

In *C. vomitoria*, *L. sericata*, *L. caesar* and *P. terrae-novae* the corpus cardiacum is incorporated *in toto* in the ventral wall of the aorta above the larval brain. During the post-feeding prepupation phase (except in *Lucilia* larvæ in diapause) it is clearly delimited by its content of bluish material identifiable as neuro-secretory material by Gomori's chrome-haematoxylin-phloxin stain and demonstrable by dark-field microscopy.

In *C. vomitoria*, *L. sericata* and *L. caesar*, the ring is solely formed by the two peritracheal glands, which unite at their ventral point of junction with the aorta behind the posterior limit of the corpus cardiacum, the dorsal branch of the recurrent nerve entering that organ at this point. Dorsally, these peritracheal glands unite above the aorta, where they overlie the corpus allatum and form an anterior prolongation which is attached to the cephalopharyngeal band as described by Possompes in *C. erythrocephala*.

In the latter species, the corpus cardiacum is similarly situated, but it is prolonged downwards towards the brain and partly enveloped by the peritracheal glands at their ventral junction to form an integral part of the ring. In *P. terrae-novae* larvæ, at the cessation of feeding, the separate identity of the two peritracheal glands is clear. They are attached ventrally to the aorta on either side of the corpus cardiacum at its posterior end, and dorsally there are two anterior prolongations attached to the single cephalopharyngeal band. Furthermore, these glands are not attached to the two cerebral tracheæ as in the other species. There is a unique tracheal supply

to the peritracheal glands and the corpus cardiacum arising from the proventricular tracheal system in this, the only species with trachea entering the corpus cardiacum.

There are in all species two pairs of nerves from the brain to the corpus cardiacum, as Burt⁴ recorded in *C. vomitoria*. Only one pair issues from the cerebral commissure, the thinner pair identified by Thomsen as the internal nerves of the corpus cardiacum (NCC I), which join the anterior part of the corpus cardiacum. The two thicker nerves which he identifies as the external nerves of the corpus cardiacum (NCC II) issue from the posterior inner faces of the cerebral hemispheres in the location indicated by Possompes for the only NCC he recognizes. Owing to the downward extension of the corpus cardiacum these nerves are shorter and less readily detectable in *C. erythrocephala*. Possompes notes two fine strands in the vicinity of the nerves, joining the brain and the ventral region of the ring, the nervous nature of which is not evident, implying that these may have been wrongly identified as nerves. These may, in fact, be the two fine strands of contractile fibres joining the lateral wall of the aorta above the corpus cardiacum to the connective tissue sheath of the cerebral hemispheres beside the point of entry of the NCC II on each side.

Thus the ring in larvæ of Cyclorrhapha is not, as hitherto published accounts might suggest, invariably a three-component structure, and the corpus cardiacum does not always form an integral part of the ring. There are two pairs of NCC in the Calliphorinae examined so far, and so the general statement of Cazal⁵ derived from observations on larvæ and adults and supported by Possompes, that there is total extracerebral fusion of the NCC in all Diptera, is not tenable, though it may be valid so far as adults are concerned. The arrangement of the retrocerebral endocrine organs and their tracheal associations is similar in *C. vomitoria*, *L. sericata* and *L. caesar*, with a variation in the location of the corpus cardiacum in *C. erythrocephala*. The divergence in *P. terrae-novae* is so great as to cast doubt either on its present taxonomic position or on the value of these internal anatomical details as taxonomic features.

Fuller accounts of these investigations will be published elsewhere.

ALASTAIR FRASER

Zoology Department,
University,
Glasgow, W.2.
Dec. 3.

¹ Thomsen, M., *Dan. Biol. Skr.*, 6, No. 5 (1951).

² Possompes, B., *Arch. Zool. Exp. et Gen.*, 89, 203 (1953).

³ Weismann, A., *Z. wiss. Zool.*, 14, 187 (1864).

⁴ Burt, E. T., *Proc. Roy. Soc. B*, 124, 13 (1937).

⁵ Cazal, P., *Bull. biol. Fr. et Belg.*, Supp. 32 (1948).

Putrescine as an Essential Growth Factor for a Mutant of *Aspergillus nidulans*

NOTHING is known of the metabolic function of diamines, such as putrescine and cadaverine, in spite of their widespread occurrence in Nature. Putrescine has been reported as a growth factor for certain strains of *Haemophilus parainfluenzae*¹ and of *Neisseria perflava*². There appears to be no report of a fungus requiring it.

Among a series of nutritional mutants of *Aspergillus nidulans* obtained after ultra-violet irradiation by the usual techniques³, one was found to require putrescine (1:4 butane-diamine), 1 mgm./litre allowing full growth. Spermidine can replace putrescine, but is only one-tenth as active at the same molar concentrations. The following compounds structurally related to putrescine were inactive: pyrrolidine; 1:4 butane-diol; 1:2 ethane-diamine; 1:3 propane-diamine; 1:5 pentane-diamine (cadaverine); 1:6 hexane-diamine; 1:7 heptane-diamine; ornithine; citrulline; adipic acid; α -amino-adipic acid; and α -amino- δ -hydroxy-valeric acid.

The activity of putrescine was competitively inhibited by 1:3 propane-diamine and by cadaverine, the molar ratios of inhibitor to putrescine for half-maximal growth being about 600 to 1 and 300 to 1 respectively. Ornithine was not inhibitory but lysine weakly so, possibly due to its decarboxylation to cadaverine. In *Haemophilus*, 1:3 propanediamine and also cadaverine are reported not to inhibit competitively growth on putrescine^{1b}.

The hereditary difference between parent strain and mutant of *Aspergillus* is determined by a single gene as shown by appropriate crosses.

P. H. A. SNEATH

Department of Genetics,
University of Glasgow,
and

National Institute for Medical Research,
London, N.W.7.

¹ Herbst, E. J., and Snell, E. E., (a) *J. Biol. Chem.*, 176, 989 (1948); (b) 181, 47 (1949).

² Martin, W. H., Pelczar, M. J., and Hansen, P. A., *Science*, 116, 483 (1952).

³ Pontecorvo, G., Roper, J. A., Hemmons, L. M., Macdonald, K. D., and Bufton, A. W. J., "Advances in Genetics", 5, 141 (1953).

Extraction of Pigment from Cooked Cured-Meat Products

It is well known in the food trade that the colour of cooked cured-meat products fades rapidly on exposure of the products to air and light, the rapidity of fading increasing with the intensity of the light, and being particularly marked if the proportion of light of shorter wave-lengths is large. A considerable amount of investigation has been carried out in recent years into the chemistry of cured-meat products and of model nitrite-haemoglobin systems, much of it with this practical problem in mind. Investigations have been rendered more difficult by the fact that denatured globin-nitric oxide myohaemochrome—the pigment to which cooked cured-meat products are generally agreed to owe their colour—is insoluble in most solvents. A method has been developed in these laboratories whereby an important part of the molecule—the highly coloured nitric oxide haem moiety—can be rendered soluble in some organic solvents by treatment of the cooked cured meat with acetone. This greatly facilitates measurement of its spectroscopic characteristics and its general behaviour towards light, oxygen, etc., measurements from which some inferences may be drawn about the behaviour of the parent pigment.

Haldane¹ obtained a weak solution of coloured material from cooked salted (cured) meat by extraction with alcohol. During experiments in these laboratories, it was found that considerably more pigment

could be obtained in solution if ground cooked cured meat was extracted with acetone rather than with alcohol. Even readier extraction was obtained if the ground meat was first well wetted with acetone and then extracted with diethyl ether. The resulting solution was bright red in colour, and measurement of the absorption spectrum in a 'Unicam' S.P. 500 photoelectric absorption spectrophotometer showed the presence of three absorption bands with maxima at 563, 537-42 and 480 m μ . Qualitatively, closely similar absorption curves were obtained using either beef or pork as the source of the pigment, though beef, having a much higher initial myoglobin content, gave much stronger solutions. The position of the maximum extinction of the β -band varied somewhat with the species and the solvent used, the range being indicated above (pork, in acetone, 537 m μ ; beef, in acetone, 540 m μ ; beef, in acetone-ether, 542 m μ).

The ethereal solution obtained by this method contained appreciable quantities of water and acetone, but appeared to be free from protein. Moreover, on shaking the ethereal solution with dilute alkali, the coloured material passed into the aqueous layer, without any apparent major change in spectrum, as viewed through a Hartridge reversion spectroscope. (This alkaline solution rapidly became cloudy, so that fuller measurements of the spectrum were not possible.) Even on the addition of sodium hydrosulphite to this alkaline solution, no haemochrome bands could be detected in the spectrum. If now an alkaline solution of globin was added to this solution, however, a typical two-banded haemochrome spectrum at once appeared.

If cooked cured meat was extracted directly with alkali (0.5 N sodium hydroxide) the absorption curve of the resulting solution was fairly similar to that of an aqueous solution of unheated nitric oxide myoglobin, having maxima at 576 and 542 m μ . Addition of sodium hydrosulphite to this solution resulted in the immediate appearance of a typical haemochrome spectrum.

From these findings it was at first thought that the material obtained in the ethereal extractions of cured meat was nitric oxide haem. Attempts were therefore made to produce this compound from haematin in ethereal solution. This could only be done, however, in the presence of acetone, and it was realized that the compound is probably a loose nitric oxide haem-acetone complex similar to the haem-acetone and haem-alcohol complexes previously described². It can readily be formed by pouring a solution of acid haematin in ether into a few drops of aqueous acetone in which have been dissolved a small crystal of sodium nitrite and a small amount of sodium hydrosulphite. The product prepared in this way has an absorption spectrum identical with that obtained by an acetone-ether extraction of cured-meat products (λ_{max} , β -band, 541 m μ).

Preliminary studies of this red nitric oxide haem-acetone compound have shown that it is sensitive to light in the presence of oxygen, a solution turning brownish-yellow on exposure. Exclusion of either light or oxygen greatly increased its stability. The absorption curve of the light- and oxygen-affected solution is almost identical with that of acid haematin in ethereal solution, showing distinct maxima at 640, 541 and 510 m μ , with a slight shoulder on the curve at 585 m μ .

It is hoped to publish a fuller account of the properties of this compound and related derivatives

elsewhere. We thank the Director and Council of the British Food Manufacturing Industries Research Association for permission to publish this communication.

J. I. ANDERTON
D. J. LOCKE

The British Food Manufacturing
Industries Research Association,
Randalls Road,
Leatherhead, Surrey. Jan. 5.

¹ Haldane, J., *J. Hygiene*, 1, 115 (1901).

² Hamsik, A., *Z. physiol. Chem.*, 190, 199 (1930).

Mechanism of Sclerotin Formation : the Participation of a Beta-Glucoside

SCLEROTIN, a skeletal material commonly found in invertebrate animals¹, was shown by Pryor² to consist of protein, hardened by reaction with an *o*-quinone. He gave an account of the formation of the ootheca of the cockroach, *Blatta orientalis*, which is composed of sclerotin. The ootheca is derived from the secretions of the two colleterial glands, and it is the larger left gland that secretes the structural protein. Pryor found that a phenolic substance, later shown to be protocatechuic (3:4-dihydroxybenzoic) acid³, was abundantly present in the fluid within the ootheca, and he attributed the secretion of this phenol to the right gland. There was evidence for supposing that this oxidation to a quinone was enzymatic.

The results of our experiments with the colleterial glands of both *Blatta orientalis* and *Periplaneta americana* do not entirely support this explanation. In agreement with Pryor and others³, the presence of protocatechuic acid in the ootheca has been demonstrated chromatographically and spectroscopically. Also, the protein secretion of the left gland has been found to be converted to sclerotin if it is incubated with synthetic protocatechuic acid, or the oothecal fluid (containing the natural acid), or with homogenized right-gland tissue. All attempts, however, to detect protocatechuic acid in the right gland have failed. Homogenates, extracts and hydrolysates of the gland have been found to contain only small amounts of phenols, none of which is protocatechuic acid. The colour reactions of the gland with ferric chloride, argentammonium solutions, and diazonium compounds bear no relation to the very intense reactions given by oothecal extracts. It is concluded that the right gland is not the gland which secretes the phenol operative in the tanning process.

On the other hand, homogenized left-gland tissue, or alcoholic extracts of it, have been found, by the use of paper partition chromatography, to contain considerable amounts of a substance (R_F 0.58 in butanol-acetic acid-water, 4-1-5) which shows the reactions of a phenol and strongly absorbs ultraviolet light in the region of 250 m μ , but which does not have the reducing properties of a dihydroxyphenol. This substance constitutes some 10 per cent of the dry weight of the gland. After four hours incubation at 37° C. with right-gland tissue, it is converted completely to α -glucose and protocatechuic acid. It is laevorotatory, and it is cleaved by dilute acids and by β -glucosidase preparations. It has chromatographic properties which are identical with those of a synthetic specimen of 3-hydroxy-4-(β -glucopyranosido)-benzoic acid, and of this glucoside extracted from the faeces of locusts injected with protocatechuic acid.

The activity of the secretion of the right gland led us to suppose that it contained a β -glucosidase. In confirmation of this, it has been found that right-gland tissue will bring about the hydrolysis of salicin, a β -glucoside from willow bark. Moreover, a preparation of β -glucosidase from yeast, added to left-gland tissue, has the same effect as the addition of right-gland tissue; namely, liberation of protocathechuic acid and glucose.

Thus, the mechanism of sclerotin formation in this instance can be explained as follows: the left gland contains the protein to be tanned, polyphenol oxidase¹, and the above-mentioned glucoside; the right gland contains a β -glucosidase. At oviposition, when the secretions are mixed, the glucosidase liberates the *o*-dihydroxyphenol. This is oxidized in the presence of the oxidase to the *o*-quinone, which reacts with the protein, making it hard and insoluble. Preliminary experiments indicate that this process is not confined to the glands which secrete the ootheca, but is of widespread occurrence. In the light of the comparative rarity of aromatic glucosides in animals², and of the extracellular nature of the reactions, the processes are of considerable biochemical interest.

It should be pointed out that histochemical tests carried out on colleterial gland tissue give most misleading results. The glucoside is readily oxidized by periodic acid, yet the left gland gives no periodic acid/Schiff reaction. On the other hand, the right gland gives a very strong reaction. It is to be supposed that the glucoside, which we have found to be soluble in both water and ethanol, is lost during the preparation of sections. The strong periodic acid/Schiff reaction of the right gland may be due to the carbohydrate present in the enzyme³.

We wish to thank Dr. Saiyid Ahmad Shafiq, with whom we collaborated for a period, and Prof. A. C. Hardy, Sir Rudolph Peters, and Dr. John R. Baker for advice and encouragement.

P. C. J. BRUNET
P. W. KENT

Department of Zoology,
and

Department of Biochemistry,
Oxford. Dec. 22.

¹ Brown, C. H., *Nature*, 165, 275 (1950).

² Pryor, M. G. M., *Proc. Roy. Soc., B*, 128, 378 (1940).

³ Pryor, M. G. M., Russell, P. B., and Todd, A. R., *Biochem. J.*, 40, 627 (1946).

⁴ Brunet, P. C. J., *Quart. J. Micr. Sci.*, 93, 47 (1952).

⁵ Myers, C. M., and Smith, J. N., *Biochem. J.*, 56, 498 (1954).

⁶ Velbel, S., in Sumner, J. B., and Myrbaek, K., "The Enzymes", 1, Pt. 1, 589 (Academic Press, New York, 1951).

Reversal of the Fungicidal Effect of Dithiocarbamyl Compounds

A PHENOMENON which has aroused some speculation is the reversal or inversion of the fungicidal effect of the dithiocarbamyl compounds. First described by Dimond and Heuberger¹, it shows itself as a lack of toxicity at intermediate concentrations, whereas at higher and lower, growth inhibition may be nearly complete. Some explanations have been proposed^{1,2}; but none of them so far seems satisfactory.

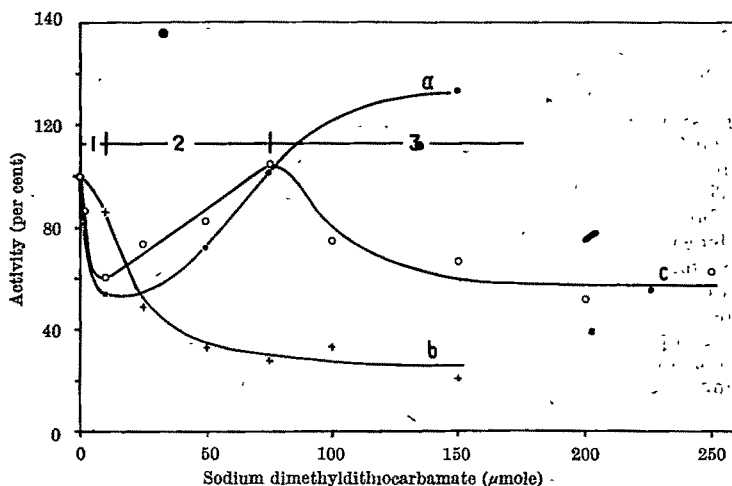


Fig. 1. Action of various concentrations of sodium dimethyldithiocarbamate on the oxidation of acetate by yeast in a phosphate buffer of pH 6.5. Curve a, 25 micromoles cupric sulphate per litre added. Curve b, the same concentration of zinc sulphate. Curve c, 15 micromoles cupric sulphate and 25 micromoles zinc sulphate added. The apparent stimulation of the respiration above the control at higher concentrations of the sodium compound in the presence of cupric ions is due to the removal of cupric ions from the substrate.

Using ordinary yeast (*Saccharomyces cerevisiae*) as the test organism, it has been found that the oxidation of sodium acetate, in a complete nutrient medium without a source of nitrogen, was inhibited by the same concentrations of sodium dimethyldithiocarbamate that caused growth inhibition. As the oxidation of glucose was considerably less inhibited, it suggests that inhibition is due to reactions connected with the uptake of acetate and formation of acetyl-coenzyme A. Comparative experiments with phosphate buffer alone, and with the various components of the nutrient solution added, demonstrated that the heavy metals had a strong synergistic effect on the action of sodium dimethyldithiocarbamate.

The effect of zinc and cupric ions was examined more closely, and curves a and b in Fig. 1 were obtained. It was further found that, in a mixture of zinc and copper salts, copper dimethyldithiocarbamate is formed first when sodium dimethyldithiocarbamate is added, the zinc compound being formed when only all cupric ions have been chelated. Copper dimethyldithiocarbamate is thus the more stable of the two complexes. It can be concluded, therefore, that in a mixture of cupric and zinc ions, the action of sodium dimethyldithiocarbamate would at first be similar to that in the presence of cupric ions only; and, after the equivalence point for the formation of the copper compound is reached, it would be similar to that in the presence of zinc ions only. Experiments have shown this to be the case (curve c, Fig. 1).

The peculiar shape of the curve of action of sodium dimethyldithiocarbamate in the presence of cupric ions can scarcely be explained by assuming that only one type of complex exists between cupric ions and dithiocarbamate.

A detailed spectrophotometric examination of aqueous solutions of dilute (20 micromoles per litre) cupric sulphate, to which varying amounts of sodium dimethyldithiocarbamate were added, was then undertaken. Using 10-cm. cuvettes in a Cary recording spectrophotometer, curves were obtained which with the smaller additions of the sodium compound, showed a peak at 3800 Å.; as more of this compound

was added, the peak seemed to disappear, and the normal absorption maximum for the copper compound at 4600 Å. (in carbon tetrachloride 4350 Å.) emerged. At shorter wave-lengths, the spectra were very similar, with the exception that the maximum at 3100 Å. was less pronounced at lower concentrations of the sodium compound.

The peak at 3800 Å. seemed to reach a maximum at about the same concentrations of sodium dimethyldithiocarbamate which, in the presence of cupric ions of a similar concentration, caused maximal inhibition of growth and acetate oxidation (about 6 μ moles per litre of the sodium compound). It is assumed that the compound occurring under these conditions, and responsible for the maximum at 3800 Å., is the 1:1 complex of cupric dimethyldithiocarbamate, namely: $(CH_3)_2N-CS_2Cu^+$.

This compound seems to be an intermediate in the formation of the normal 1:2 complex, and it does not seem improbable that it may have some stability in very dilute solutions, in the presence of excess cupric ions.

Hence we believe that the action curve of sodium dimethyldithiocarbamate on micro-organisms can be explained as follows: section 1 of curve *c* (Fig. 1): strong inhibition due to the formation of the 1:1 complex of the copper compound; section 2: reversal of the inhibition due to transformation of the 1:1 complex to the normal 1:2 complex, which is practically insoluble; section 3: inhibition due to formation of the zinc compound and other heavy-metal complexes with less stability.

It should be mentioned that, besides being valid for all dithiocarbamates (not *bis*-dithiocarbamates), this explanation also applies to the inversion phenomenon observed with tetramethylthiuram disulphide and tetramethylthiuram monosulphide, because these compounds in biological systems have been found to be reduced or hydrolysed to form dithiocarbamate ions.

The findings reported here also explain some of the disagreements found in the literature regarding the toxicity of copper dimethyldithiocarbamate.

A full account of the physiological effect of the dithiocarbamyl compounds on fungi will be published elsewhere.

JOSTEIN GOKSØYR

Central Institute for Industrial Research,

Oslo.

Jan. 12.

¹ Dimond, A. E., Heuberger, J. W., and Stoddard, E. M., Connecticut Agric. Exp. Sta., Bull. 451, 635 (1941).

² Blackith, R. E., *Nature*, 161, 20 (1945). Montgomery, H. B., and Shaw, H., *Nature*, 161, 333 (1943).

Labelling Locusts with Radioactive Isotopes

FOLLOWING successful attempts at marking Lepidopterous larvae with radioactive sulphur with the object of investigating population dynamics, larval death-rate, and dispersal¹, an opportunity presented itself of applying similar principles to locusts (*Locusta migratoria* L. and *Locustana pardalina* Walk.). Accordingly, a series of laboratory experiments was carried out on (a) locust hoppers and (b) locust adults. In each case, phosphorus-32 was given and feeding permitted for twenty-four or forty-eight hours, and this was followed by their return to normal food; thereafter, each having been anaesthetized by carbon dioxide, the individual counts

per minute were recorded with a Geiger counter, as also were those for their excreta and exuviae.

(a) *Locust hoppers*. Large numbers of first- and second-instar hoppers were fed on hydroponic maize and grass, grown in solutions of phosphorus-32. Thus the isotope was given in an organic state. Also, sieved wheat bran was impregnated with labelled phosphoric acid, and a strength of 10 μ c. of phosphorus-32 per gm. of bran was found adequate. Uniformity of spread was checked by dyes. It was established that 40 gm. of sieved wheat bran would take up 100 c.c. of radioactive solution which, when mixed, gave a satisfactory spread of activity. Rapid drying at high temperature followed by stirring (a mask being worn) was essential; otherwise fermentation, resulting in deaths of locusts, took place. Known strengths of inorganic phosphorus-32 were thus ingested.

Individuals made radioactive during their first and second instars gave counts easily recognizable three to five weeks later, after they had become adult. There was no apparent difference in this respect between the *gregaria* and *solitaria* phases. The total phosphorus loss (exchange plus decay) after the initial twenty-four hours feed was 80 per cent for the next fortnight.

For the first twenty-four hours following radioactive feeding, each hopper lost about half its radioactivity and, during this period, the excreta gave correspondingly high counts. Thereafter, the loss was negligible. Exuviae contained very little phosphorus-32.

There was no apparent difference between hoppers that ingested organic phosphorus-32 and those that ingested inorganic radioactive phosphorus.

At a temperature of 85°–90° F., there were, in both cases, individuals which showed very low or no radioactive counts. This was found to be due to the fact that, during ecdysis, the hopper does not feed for a period of about twenty-four hours. A standard error can therefore be worked out for the proportion of hoppers which fail to become recognizably radioactive during their feeding time at a given temperature. This may account for the deficiency of radioactive releases reported by other workers (Putnam, L. G., personal communication) even when sampling is carried out immediately after release.

Among individuals feeding on radioactive hydroponic plants, a much greater uniformity of count was obtained by crowding, so that no one hopper fed exclusively on one leaf. The variance of the leaf counts was thus equalized.

Treated hoppers had a slightly higher mortality rate than untreated hoppers, and death usually occurred during ecdysis. The speed of metamorphosis appeared to be slowed down.

(b) *Adult locusts*. Similar feeds, both organic and inorganic, were given to adult locusts, and counts of up to 27,000 per minute at a distance of half an inch were obtained. With adults, the counts were much more uniform than with hoppers. Using a 'Devilbliss' No. 15 atomizer, adult *L. migratoria* were also sprayed with phosphorus-32 in a wetting agent and their subsequent counts recorded.

As in the case of hoppers, but to a slightly lesser degree, phosphorus-32 was rapidly absorbed by adults, both as an organic and an inorganic salt, and was retained for a period of up to five weeks. Treated adults could be recognized at a distance of ten inches for a fortnight. The Geiger counts for excreta, high

for the first twenty-four hours, fell rapidly to negligible proportions, the locusts losing 45 per cent of their radioactivity during that period.

Auto-photography of adult locusts given a forty-eight-hour radioactive feed showed a concentration in the metathoracic pair of legs and in the ovaries and testes. The wings appeared to hold no phosphorus-32, as distinct from those adults, reared from radioactive hoppers, the wings of which showed up clearly on the films. This difference would permit double marking with the same isotope of both hoppers and adults within a given population.

In view of the fact that locust hoppers cast their skins frequently, external marking is of no use. This being so, there is no adequate marker available other than a radioactive isotope, and for work where a β -ray is sufficient, phosphorus with a half-life of 14.3 days is the most suitable element. There is no difference in the absorption of it by a hopper whether it is given in an organic state in grass and maize made radioactive or as an inorganic salt in bran. The bran feed is the obvious method of choice in the field, and large numbers of first- and second-instar hoppers can thus be made radioactive at comparatively low cost. Much could be learnt about hopper movement and death-rate by this method, the only one at present available. Its use, however, would entail the expenditure of much time and labour by specialized staff using costly apparatus. An attempt was made to circumvent this by an approach to Messrs. Kodak, Ltd., with the object of obtaining a β -ray-sensitive 8 mm. film trace, suitably insulated and of known length, which could be laid in the track of advancing hoppers. With random sample counts taken over this for fixed periods, subsequent developing would show the passage of radioactive hoppers. Unfortunately, this method is so far inapplicable for β -rays, as there is no strip sufficiently sensitive for so short a traverse. For the present, therefore, orthodox methods, involving capturing hoppers with a net and scanning the bag with a Geiger counter, would have to be used, though direct scanning of hopper concentrations could possibly be undertaken at night. Future developments in the direction of using a portable scintillation counter, with material emitting a γ -ray, may simplify this.

Unless some automatic recording device can be found, it seems that for labelling adult locusts radioactive isotopes have no advantages over the well-tried colour paints, with which adults have been marked in the past for observing dispersal². Untrained workers can see and record these, whereas radioactive locusts demand highly skilled technicians using special apparatus.

I wish to thank the following members of the University of Cape Town who gave me facilities: Prof. J. Day, Department of Zoology; Dr. A. M. Cormack, Department of Physics, for much technical advice; and Prof. E. Isaac and Dr. E. Schelpe, Department of Botany. I am also indebted to the Anti-Locust Research Centre for providing a grant for this work, and to the Nuffield Foundation for allowing me six months leave of absence. Full results have been deposited with the Anti-Locust Research Centre, British Museum (Natural History), London, S.W.7.

H. B. D. KETTLEWELL

Genetics Laboratory, Department of Zoology,
University of Oxford. Jan 28.

¹ Kettlewell, H. B. D., *Nature*, 170, 584 (1952).

² Davey, J. T., *Nature*, 172, 720 (1953). Lea, A., *Sci. Bull. Agric. S. Africa*, No. 344 (Locust Research Series No. 15) (1953). Richards, O. W., *Anti-Locust Bull.*, No. 15 (1953).

Elution of Isoagglutinins adsorbed by Platelets

THE existence of A, B, O and AB groups in thrombocytes, corresponding to these groups in red blood cells, has been reported^{1,2}. The identity of the A and B antigens in platelets and red blood cells has been proved by: (1) platelet agglutination with antisera; (2) cross-adsorption of isoagglutinins with thrombocytes and erythrocytes; (3) inhibition of isoagglutinins with saliva from secretors; and (4) neutralization of antisera with A- and B-group specific substances. Similar results of agglutination of platelets were reported by Ruggieri and Bolognesi³. Adsorption of A- and B-isoagglutinins with platelets was reported by Moureau and André⁴.

The present communication deals with studies on eluates of antisera adsorbed with large amounts of platelets. The method of elution used is based on that of Landsteiner and Miller⁵. Details of the preparation of platelet suspensions and sera have been described elsewhere².

To a platelet sediment prepared from 40–50 ml. of blood, 0.5 ml. of normal saline was added, and the tube shaken gently for 3–5 min. at about 6° C., to obtain a homogeneous concentrate of platelets. This suspension was added to 0.7 ml. of a high-titred antiserum in a siliconed tube and left for 15–20 hr. at 6° C., being occasionally shaken. After centrifugation at 2,000 r.p.m. for 10 min., the adsorbed serum was pipetted off, and the platelet sediment washed three times in normal saline to ensure removal of traces of serum.

The washed platelet sediment was resuspended in 0.4 ml. of normal saline and vigorously shaken by hand in a water-bath at 56° C. for 5 min. It was then centrifuged at 56° C. for 1 min. at 3,000 r.p.m. and the supernatant eluate was immediately removed. Special precautions were taken to ensure a constant temperature of 56° C. during elution.

Using the above technique, eluates of fifteen different A, B and O sera were prepared and examined for agglutinating capacity against erythrocytes and thrombocytes. Typical results of elution experiments are given in Table 1.

Table 1

Titre of serum before adsorption with platelets	Adsorption with platelets of blood group	Titre of serum after one adsorption with platelets	Titre of eluate against red blood cells
Anti A 1:128	A	1:2	1:16
Anti B 1:256	B	1:64	1:32
Anti A 1:64	AB	1:4	1:16
Anti B 1:32		1:2	1:16
Anti A 1:128	O	1:64	0

Eluates with a titre of 1:16 and higher also agglutinated platelet suspensions of the corresponding blood group.

J. GUREVITCH
D. NELKEN

Hebrew University–Hadassah Medical School,
Jerusalem.
Dec. 22.

¹ Gurevitch, J., and Nelken, D., *Nature*, 173, 356 (1954).

² Gurevitch, J., and Nelken, D., *J. Lab. and Clin. Med.*, 44, 562 (1954).

³ Ruggieri, P., and Bolognesi, G., *Boll. Soc. Ital. Ematologia*, 2, 12 (1954).

⁴ Moureau, P., and André, A., *Vox Sanguinis*, 4, 46 (1954); *Nature* 174, 88 (1954).

⁵ Landsteiner, K., and Miller, C. P., *J. Exp. Med.*, 42, 852 (1925).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, May 9

LABORATORY ANIMALS BUREAU (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 10 a.m.—Symposium on "The Breeding of Laboratory Animals".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. D. L. Linton: "The Nature and Significance of Tors".

Tuesday, May 10

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Dr. D. A. Long: "The Response of the Host to Bacterial Infection" (Almroth Wright Lecture).

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF NAVAL ARCHITECTS (joint meeting with the INSTITUTE OF MARINE ENGINEERS, at 85-88 The Minories, London, E.C.3), at 5.30 p.m.—Symposium on "Advanced Machinery Installations Designed for the Maximum Saving in Weight and Space".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Herbert C. Brown (Purdue University): "A Proposed Quantitative Treatment of Aromatic Substitution".*

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. Harriett Ephrussi-Taylor (Université de Paris): "Induced Transformations of Bacteria".* (Further lectures on May 11 and 13.)

Wednesday, May 11

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Mrs. C. Cockburn: "Social Insurance and its Relation to the Relief of Distress". (Second of seven University Extension Lectures on "The Development and Pattern of the Social Services".)

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4.30 p.m.—Annual General Meeting, followed by Prof. H. S. W. Massey, F.R.S.: "Progress and Problems of Physics to-day" (Presidential Address).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Rittmann (University of Cairo): "Mountain-building and Volcanism".

MEDICAL RESEARCH COUNCIL (at the National Institute for Medical Research, Mill Hill, London, N.W.7), at 5 p.m.—Dr. Emil L. Smith (University of Utah): "The Chemistry of Antibodies and Gamma Globulins".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Symposium on "Linear Programming". Papers by Dr. S. Vajda, Dr. E. M. L. Beale, Dr. G. Morton and Mrs. A. H. Land.

INSTITUTE OF PETROLEUM (at 28 Portland Place, London, W.1), at 5.30 p.m.—Mr. E. H. Walker, Mr. R. M. Eltringham and Mr. A. Utchick: "Evaporation Losses from Petrol Storage Tanks in the U.K.".*

INSTITUTE OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Papers on "Transistors and their Semi-Conductor Devices".

ROYAL INSTITUTION, LIBRARY CIRCLE (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. Ralph Cory: "Library Reminiscences".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting, followed by the Chairman's Address—"Wartime Food Processing Problems in Retrospect".

Thursday, May 12

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Film illustrating some of the research activities of the Istituto Superiore di Sanità, Rome, with a brief introductory address by the Director-General—Prof. D. Marotta. Prof. E. B. Chain, F.R.S.: "Some Recent Advances in Carbohydrate Metabolism".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Emil L. Smith (Utah): "Mode of Action of Proteolytic Enzymes". (Further lectures on May 16 and 19).*

INSTITUTE OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. D. H. Little and Mr. Augustus Smith: "Some Steel Structural Frames Designed on Elastic Theory".

INSTITUTE OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Image Intensification in Radiology".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department Imperial College, Imperial Institute Road, London, S.W.7), at 6.0 p.m.—Mr. D. W. Robinson and Mr. R. S. Dadson: "A Re-determination of the Equal-loudness Relations for Pure Tones".

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Prof. Fredrik Nilsson (Sweden): "Horticultural Research in Sweden with special reference to Berry Fruits".*

Friday, May 13

SOCIETY FOR ANALYTICAL CHEMISTRY, BIOLOGICAL METHODS GROUP (the Lecture Hall of the Royal Society of Tropical Medicine and Hygiene, 28 Portland Place, London, W.1), at 2.30 p.m.—Meeting "Biological and Microbiological Methods of Estimating Vitamin".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTE OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. Manham and Dr. D. C. Sweeney: "Hydraulic Look"; Mr. A. E. Bingham: "Liquid Springs: Progress in Design and Application".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. B. W. Douglas: "The No-Man's Land between Conductors and Insulators".

Saturday, May 14

BIOCHEMICAL SOCIETY (at the University, Reading), at 11 a.m.—Scientific Papers.

BRITISH INTERPLANETARY SOCIETY (in the York Hall of Caxton Hall, Caxton Street, Westminster, London, S.W.1), at 6 p.m.—Short Paper Evening.*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B (graduate in mathematics, engineering or science, and with teaching or industrial experience), IN THE DEPARTMENT OF MATHEMATICS—The Registrar, College of Technology and Commerce, The Newark, Leicester (May 12).

CHAIR OF PHYSICAL METALLURGY at the Imperial College of Science and Technology, London, S.W.7—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 13).

ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS—The Registrar, The University, Liverpool (May 14).

LECTURER (with a degree in physics and suitable teaching experience) IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.5 (May 14).

LECTURER (with a good honours degree and an interest in the history and philosophy of science) IN EDUCATION—The Registrar, The University, Sheffield (May 14).

LECTURER (with a good honours degree, and preferably with teaching and industrial experience) IN PHYSICS, and an ASSISTANT, Grade B, IN PHYSICS, at Bournemouth Municipal College of Technology and Commerce—The Chief Education Officer, Town Hall, Bournemouth (May 14).

LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY—The Registrar, King's College, Newcastle-upon-Tyne (May 14).

RESEARCH FELLOWS AND RESEARCH ASSISTANTS IN THE DAVY FARADAY RESEARCH LABORATORY of the Royal Institution, to work in the fields of X-ray crystallography and metal physics—Sir Lawrence Bragg, F.R.S., Royal Institution, 21 Albemarle Street, London, W.1 (May 14).

SENIOR PHYSICIST (with a thorough knowledge of classical and modern physics, and with research experience of Ph.D. standard) IN THE REGIONAL PHYSICS DEPARTMENT—The Secretary and Treasurer, Board of Management for Glasgow Western Hospitals, 10 Park Circus, Glasgow, C.3 (May 14).

LECTURER IN EDUCATION—The Principal, Borough Road College, Isleworth, Middx (May 16).

LECTURER IN MATHEMATICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 16).

LECTURER or ASSISTANT LECTURER (with experience of university teaching, and preferably with special qualifications in petrology) IN THE DEPARTMENT OF GEOLOGY—The Secretary and Registrar, The University, Southampton (May 16).

LECTURER (with special interests in the teaching of biology) IN GENERAL SCIENCE, at Didsbury Training College—The Chief Education Officer, (S3/L), P.O. Box 480, Education Offices, Manchester 3 (May 16).

ASSISTANT LECTURER IN PHYSICS, and a LECTURER IN MECHANICAL ENGINEERING at Manchester Municipal College of Technology (Faculty of Technology in the University of Manchester)—The Registrar, College of Technology, Manchester (May 23).

LECTURER (with a degree or recognized diploma in mining) IN THE DEPARTMENT OF MINING AND GEOLOGY—The Principal, Wigan and District Mining and Technical College, Wigan (May 23).

PROFESSOR OF APPLIED ELECTRICITY AND HEAD OF DEPARTMENT, and a PROFESSOR OF PHILOSOPHY AND HEAD OF DEPARTMENT—The Secretary and Registrar, University College of North Wales, Bangor (May 23).

ELECTRONICS ENGINEER or PHYSICIST (with recognized professional qualifications in electronics, and an interest in computing machines) IN THE COMPUTATIONAL LABORATORY, to work on problems of character recognition in connexion with mechanical translation—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (May 23).

ASSISTANT (science graduate) IN THE BACTERIOLOGY DEPARTMENT—The Medical Superintendent, Western Infirmary, Glasgow (May 23).

CHAIR OF MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (May 30).

CHAIR OF ENGINEERING (Mechanical) at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, May 31).

HEAD OF THE DEPARTMENT OF GEOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 31).

LECTURER IN PHYSICS—The Secretary of University Court, The University, Glasgow (May 31).

ANALYTICAL CHEMIST, Principal Research Officer or Senior Research Officer grade, with the Australian Atomic Energy Commission, to supervise an analytical service and develop new analytical methods in chemistry and radiochemistry—The Secretary, Australian Atomic

Energy Commission, 45 Beach Street, Coogee, N.S.W., Australia, or to A.A.E.C. Liaison Officer, Australia House, Strand, London, W.C.2 (June 1).

ASSISTANT LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (June 4).

COKE RESEARCH FELLOW (graduate of a British University) for research in the Department of Fuel Technology and Chemical Engineering—The Registrar, The University, Sheffield (June 12).

ANALYST (with a first- or second-class honours degree with chemistry as the main subject, and preferably with a previous knowledge of the natural rubber industry) AT THE RUBBER RESEARCH INSTITUTE OF MALAYA, Kuala Lumpur, to take charge of the analytical services in the Chemical Division, and to conduct research into new methods appropriate to raw materials and products of the natural rubber industry, and a SOILS CHEMIST (with a first- or second-class honours degree and at least three postgraduate years experience) IN THE SOILS DIVISION, to undertake work on soil fertility problems with particular reference to rubber cultivation—The Secretary, London Advisory Committee for Rubber Research, Imperial Institute, London, S.W.7 (June 15).

ASSISTANT LECTURER IN PHYSICS at the University College of Kharطوم—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1.

ASSISTANT METEOROLOGIST (with H.S.C. or equivalent in mathematics and physics, and preferably with experience in forecasting) with the Nigerian Federal Government—The Crown Agents, 4 Millbank, London, S.W.1, quoting M3B/34743/TA.

BIOCHEMIST, Scientific Officer grade (preferably with some mechanical aptitude), to study the composition and purification of large-scale preparations of leaf protein—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "167".

LECTURER or ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Nottingham.

LIVESTOCK IMPROVEMENT OFFICER (with a degree in agriculture and general farming experience, and a bias towards livestock management), in Uganda, to manage one of two experimental farms at which problems of animal breeding, feeding and management are under investigation—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.87/9/06.

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry and with experience in the operation of chemical plant in the explosives field), to take charge of explosive research and development work on pilot plant scale and to direct pilot plant operation—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 837/WGE/2.

READER and SENIOR LECTURERS or LECTURERS IN CHEMISTRY—The Dean, College of Arts and Science, Baghdad, Iraq.

SCIENTIFIC OFFICER (preferably with previous research experience) IN THE CHEMISTRY DEPARTMENT, for work on the physical chemistry of soil—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent in electrical engineering or physics, and with a bias towards electronics) at an R.A.F. Experimental Establishment in Norfolk, for the development and adaptation of radio equipment pulse techniques, including aerials, power supplies and displays—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.163/5A.

SENIOR LECTURER IN AGRICULTURE—The Registrar, Wye College (University of London), Wye, near Ashford, Kent.

SENIOR LECTURER IN THE DEPARTMENT OF MATHEMATICS at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with at least a first- or second-class honours degree in physics or engineering, and with research experience in some problems involving a theoretical approach to engineering, and a reasonable knowledge of workshop practice), to carry out research on fundamental problems connected with the design of ultra-high speed rotating systems—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 522/WGE/34.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with at least a second-class honours degree in physics or engineering, and preferably with some postgraduate experience in heat transfer), for experimental research work in the field of reactor cooling—The Establishments Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/296.

SENIOR SCIENTIFIC OFFICER (with at least a first- or second-class honours degree in mathematics or physics, and with a few years appropriate experience), for mathematical work associated with the design and development of radar and electronic devices—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 596/WGE/2.

and Glomerular Filtrate Flows in the Dog, with Incidental Observations of the Effects on these Flows of Compression of the Carotid and Renal Arteries. By R. V. Sellwood and E. B. Verney. Pp. 361-396. 12s. (London: Royal Society, 1955.) [212]

National Coal Board. Report of the Advisory Committee on Organisation. Pp. iii+105. (London: National Coal Board, 1955.) 2s. 6d. [222]

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute (University of London). Report of the 29th Meeting of the Ross Institute Industrial Advisory Committee. Pp. 26. (London: Ross-Institute of Tropical Hygiene, 1955.) [23]

Association of Universities of the British Commonwealth. Report of the Executive Council together with the accounts of the Association, for the year 1st August 1953 to 31st July 1954. Pp. 22. (London: Association of Universities of the British Commonwealth, 1955.) [23]

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute (University of London). Report on the work of the School for the year 1953-1954. Pp. 136. (London: London School of Hygiene and Tropical Medicine, 1955.) [23]

University of London. University College—Annual Report, 1953-1954. Pp. 97. (London: University College, 1955.) [23]

International Tin Research Council. Annual Report, 1954. Pp. 28 (Publication 233). (Greenford, Mddx.: Tin Research Institute, 1955.) [23]

Scottish Home Department. Marine Research, 1955. No. 1: The Plankton of the Waters Approaching the British Isles in 1953. By Dr. J. H. Fraser. Pp. 12. 2s. 6d. net. Freshwater and Salmon Fisheries Research. No. 7: Sixth Annual Report of the Supervisory Committee for Brown Trout Research, 1953-1954. Pp. 12. 2s. net. (Edinburgh: H.M. Stationery Office, 1955.) [23]

Other Countries

U.S. Department of Commerce. National Bureau of Standards Handbook 57: Photographic Dosimetry of X- and Gamma Rays By Margarete Ehrlich. Pp. iv+28. (Washington, D.C.: Government Printing Office, 1954.) 15 cents. [2]

Lloydia: A Quarterly Journal of Biological Science. Vol. 17, No. 1: Flora of Dominica, B.W.I. Part 1. By W. H. Hodge. Pp. 96. (Columbus, Ohio: Lloyd Library and Museum, 1954.) [2]

Smithsonian Miscellaneous Collections. Vol. 123, No. 6: A New Photographic Autobiography of Sitting Bull. By Alexis A. Proulx. (Publication 4180.) Pp. ii+4+77 plates. (Washington, D.C.: Smithsonian Institution, 1955.) [2]

United States National Museum—Smithsonian Institution. Annual Report for the year ended June 30, 1954. Pp. ix+100. (Washington, D.C.: Smithsonian Institution, 1954.) [2]

New Zealand. National Art Gallery and Dominion Museum Report of the Board of Trustees for the year ended 31 March 1954. Pp. 19. (Wellington: New Zealand Dominion Museum, 1954.) [2]

Smithsonian Institution: Bureau of American Ethnology. Bulletin 157: Anthropological Papers—Numbers 43-48. Pp. iii+415+7 plates. (Washington, D.C.: Government Printing Office, 1955 2.75 dollars.) [2]

Materiały z Konferencji fizyków w Spale. Pp. 366. (Warszawa: Państwowe Wydawnictwo Naukowe, 1954.) Cena zł. 31.20. [2]

Astronautica Acta. (Official Journal of the International Astronautical Federation.) Vol. 1, Fasc. 1. Pp. 60. (Published quarterly. Yearly subscription rates: 216 Austrian schillings; 36 D. marks; 8.60 dollars 37.20 Swiss francs; 62s.) (Wien: Springer Verlag; London: I. Maxwell and Co., Ltd., 1955.) [2]

Smithsonian Miscellaneous Collections. Vol. 126, No. 3: A Revision of Some Glanduline Nodosariidae (Foraminifera). By Alfred I. Loeblich, Jr., and Helen Tappan. (Publication 4189.) Pp. ii+9 1 plate. (Washington, D.C.: Smithsonian Institution, 1955.) [2]

United States Naval Observatory. Circular No. 55 (January 1-1955): Positions, Areas, and Counts of Sunspots, September-October 1954. By Winifred Sawell Cameron. Pp. 4. (Washington, D.C.: United States Naval Observatory, 1955.) [2]

Institut des Parcs Nationaux du Congo Belge. Exploration d'un Parc National Albert. Monographie Ethnologique de l'Hippopotame (*Hippopotamus amphibius* Linné). Par René Verheyen. Pp. 9. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1954.) [2]

Reports and Proceedings of the World Congress of Doctors for the Study of Present-day Living Conditions—Vienna, 23-25 May, 1955. Pp. xvi+384. (Vienna: Congrès Mondial des Médecins; London: Caversham Centre, 25, Caversham Road, N.W.3.) 10s. 8d. [2]

Inter-American Tropical Tuna Commission. Annual Report for the year 1953. Pp. 87. (La Jolla, Calif.: Inter-American Tropical Tuna Commission, 1954.) [2]

Chicago Natural History Museum. Fieldiana—Geology. Vol. 1, No. 20 (December 27, 1954): Notes on an Eocene Crab, *Harpactocarcinus mississippiensis* Rathbun. By Eugene S. Richardson. Pp. 219-224. 25 cents. Fieldiana—Zoology. Vol. 34, No. 1 (December 23, 1954): Some Mites of Yemen, collected by the Medical Mission of the United States, Naval Medical Research Unit No. 1. By Charles D. Radford. Pp. 295-314. 45 cents. Vol. 34, No. 2 (December 23, 1954): A New Larval Mite from Eritrea (Acarina: Trombidulidae). By Charles D. Radford. Pp. 315-318. 10 cent.

Vol. 34, No. 30 (December 23, 1954): The Annelated Corak Snak *Micurus annellatus* Peters. By Karl P. Schmidt. Pp. 319-32 10 cents. Fieldiana—Anthropology. Vol. 44, No. 1 (December 1, 1954): Proto-Lima: A Middle Period Culture of Peru. By A. Krober. Appendix: Cloths. By Dwight T. Wallace. Pp. 15 4 dollars. (Chicago: Chicago Natural History Museum, 1954.) [2]

Department of the Army: Corps of Engineers. Beach Erosion Board: Office of the Chief of Engineers. Technical Memorandum No. 52: Laboratory Study of Effect of Tidal Action on Wave-Form Beach Profiles. By George M. Watts and Robert F. Dearduff. Pp. iii+21. Technical Memorandum No. 62: Restudy of Test-Sho Nourishment by Offshore Deposition of Sand, Long Branch, New Jersey. By Robert L. Harris. Pp. iv+18. Technical Memorandum No. 69: Wave Forces on Piles: a Diffraction Theory. By R. McCamy and R. A. Fuchs. Pp. iii+17. Technical Memorandum No. 70: The Effect of Fetch Width on Wave Generation. By Thor dike Saville, Jr. Pp. ii+9. (Washington, D.C.: Beach Erosion Board Office of the Chief of Engineers, 1954.) [2]

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 931, Vol. 247 (17 February 1955): On the Assessment of Optical Images. By P. B. Fellgett and E. H. Linfoot. Pp. 369-407. 12s. 6d. Series B: Biological Sciences. No. 656, Vol. 233 (10 February 1955) The Flight Muscles of Insects—Their Anatomy and Histology: with some Observations on the Structure of Striated Muscle in General. By O. W. Tiegs. The Path of the Slow Contractile Wave in Antipod Muscle Fibre. By E. Matthes and O. W. Tiegs. Pp. 221-359+plates 17-37. 80s. No. 657, Vol. 233 (10 February 1955): The Effect of Water and of Isotonic Saline Administration on the Renal Plasma

SCIENTIFIC AND TECHNICAL MAN-POWER FOR UNDEVELOPED TERRITORIES

A DEBATE in the House of Commons on the Supplementary Estimates on March 16 took place on a motion to provide a further £300,000 in the year ending March 31, 1955, for grants-in-aid of expenses of the United Nations and of technical assistance for economic development. During the debate, the report on visits to the Technical Assistance Administration of the United Nations and to the Food and Agriculture Organization issued by the Federation of British Industries* was freely quoted and warmly commended both by Mr. Cyril Osborne, who opened the debate, and other speakers, and by the Joint Under-Secretary of State for Foreign Affairs, Lord John Hope, who replied for the Government. The report points out that Britain has a special understanding of the benefits which flow from the injection of capital and of technical and managerial skills into less-developed areas of the world. "To those areas themselves, it brings the opportunity of developing natural resources, of earning higher incomes, of securing a higher standard of life. To the more developed countries, it brings access to raw materials and a growth of trade."

All this, of course, as the report duly notes, is a great influence for peace, though naturally the Federation directs attention to the opportunities which potential improvements in agriculture provide for industrial products when half the world's acreage is still reaped with the sickle. Furthermore, technical assistance brings to underdeveloped countries the benefits of modern knowledge of nutrition and of the control and prevention of disease. But the report also gives warning that the consequent rapid growth in population may result in a lowering of the standard of living, unless it is accompanied by an immense increase in the production of food.

Perhaps the most interesting general feature of this report is, in fact, the demonstration of firm support for the Technical Assistance programme from industrialists, who frankly admit, as a result of their visits, their surprise that they know so little of what is going on. The Federation of British Industries is satisfied that the concept of technical assistance is right on broad humanitarian grounds and, in general, politically and economically sound. It has no doubt that much is done that is very good, that administrative efficiency is improving, and that many seeds are planted, some of which will germinate. It commends to British consulting engineers, contractors and manufacturers the desirability of maintaining closer touch with this work; but it was dissatisfied with the United Kingdom liaison arrangements and indicated that ideas for improving these arrangements

had arisen which it was proposed to discuss with the authorities.

Lord John Hope, who stated that from the inception of the Expanded Technical Assistance programme in 1950 up to June 30, 1954, £1,889,000 had been spent in the United Kingdom and £2,035,000 had been contributed by the United Kingdom, said that the Government would do its best to see that the programme is made as widely known as possible. There are, however, two further features of the report, both of which were stressed in the debate, that are of special importance. First, the report emphasized the importance for efficient administration of knowing in advance the scale on which its activities can be pursued. In the absence of such knowledge, for example, the staff position is insecure and good men are deterred from accepting posts. The report regards it as unfortunate that pledges by governments of their financial support for the following year are given so late as November. Believing that technical assistance is good policy and that it should be given the chance to be administered efficiently, the Federation specifically urges the Government to give a lead by announcing the scale of support it will give to the Expanded Programme for at least two years ahead, subject to Parliamentary approval.

On this point Lord John Hope declined to commit the Government, though he did not exclude the possibility of representations to the Treasury; and he referred to the example which Britain has set in the related and important matter of promptitude of payment. What he said in regard to the second point was, however, even more important. The report expresses the hope that British policy will provide for increasing the participation of the United Kingdom in this work, both financially and operationally, and in particular states its opinion that there are many technical assistance projects for which the offer of really good experts from the United Kingdom is most desirable, and urges all concerned to be readier to release men in such efforts. Lord John Hope's reply here helped to put the whole question in its proper perspective. The limiting factor, he reminded the Committee, is not so much the amount of funds as the availability of experts. Even now we are ahead in the field, and have produced more experts to help in this work than any other country. Nevertheless, as the Secretary of State for the Colonies told the House of Commons on February 2, in the debate on the second reading of the Colonial Development and Welfare Bill, there is already a grievous shortage of trained people; and there is a distinct possibility that an even greater shortage of scientific and technical experts and of trained administrators may frustrate plans for development and welfare in Nigeria and elsewhere in Africa. On his recent visit

* United Nations Technical Assistance: Report on visits to the Technical Assistance Administration of the United Nations in New York, in September 1954, and to the Food and Agriculture Organisation in Rome, in October 1954. Pp. 38. (London: Federation of British Industries, 1955.) 2s. 9d.

to Nigeria, he found that it is generally recognized that development and welfare depend on the availability of administrative and technical experts; and recent events in the Sudan have at least indicated that, even if the men can be found, they will not be available unless the appropriate conditions are provided.

This, of course, is a question that has two sides; but even where in the backward areas conditions of trust and esteem encourage technical experts from the more advanced areas to come forward and help, there is for consideration also the question whether long-term interests are not best served by training nationals for those areas in the universities and technical colleges and other institutions of the advanced countries. In the present man-power situation, indeed, it may be the only possible policy for such a country as Britain to adopt in order to avoid the dispersal of resources to the point where they become ineffective. Mr. Nehru, for example, is reported to have requested the services of a large number of British physicists for the development of nuclear energy in India. Even without regard to the proportion of Britain's scientific effort already deployed in this field, it may well be argued that Britain can best serve India in this field by providing the training places at Harwell and elsewhere, in accordance with the policy announced even before the White Paper on nuclear power was published. Sir Edward Appleton, indeed, has suggested that in view of the man-power situation it would be preferable to concentrate upon building the nuclear energy plants in Great Britain; but that involves other and more debatable assumptions, although the possibility was envisaged by Lord Salisbury in speaking of the nuclear power programme in the House of Lords on February 15.

It was a welcome feature of the debates on the second reading of the Colonial Development and Welfare Bill, both in the House of Commons and later in the House of Lords on February 24, that due weight was given to this question of scientific and technical man-power. Mr. Lennox-Boyd frankly recognized that the limits of expenditure are set largely by the shortage of trained men. In fact, the figure of £80 million new money for the period 1955-60 proposed in the Bill, making, with the unspent £40 million of the existing provision, a total of £120 million, as foreshadowed in the recent report on the administration and use of the funds provided under the Colonial Development and Welfare Acts*, was arrived at after examining the outline forecasts of the Colonial Governors in the light of such physical limits to development. This money, which the Earl of ~~Monster~~ said represents an increase of 70 per cent over actual expenditure in the previous quinquennium, is not, of course, the only source of funds for Colonial development and welfare. In fact, Mr. Lennox-Boyd estimated the total investment in British Colonial territories by the United Kingdom and the Colonial governments as some £600 million,

excluding expenditure in the Central African Federation and certain large schemes such as the Volta River Scheme.

In these circumstances the question of priorities becomes all-important, and it should be the easier to determine the right priorities and secure adequate support in executing them now that there is such general agreement on the shortage of technical skill at all levels. Mr. James Griffiths, for example, fully agreed with all that Mr. Lennox-Boyd had said on this point, and added that in all the provisions we have made for technical assistance we should make it clear that our purpose is to train indigenous technicians as quickly as possible. Mr. Griffiths, and Sir Roland Robinson, who followed him, welcomed the provision to be made everywhere for extended technical education, as did Mr. Thomas Reid, while Mr. John Tilney referred to the bearing of this on agricultural production and to the need for more mobility on the part of administrators. With the changing conditions in different parts of the world, he suggested that it might be possible to provide continuous service for a corps of highly qualified administrative officers, though not necessarily always in the same territory or the same part of the world, and that this is perhaps a problem which Britain should tackle, not alone but in co-operation with other Western countries.

Clearly that is a suggestion that bears closely on the supply of scientific and technical experts and their most efficient use, and it reminds us also of the extent to which the problems of man-power in Colonial development and welfare are interlocked. It is not simply a matter of deciding whether social or economic development should have priority. As Mr. Philips Price pointed out, we cannot get satisfactory training for Africans until we have enough entrants into the training colleges, and that in turn depends on getting enough teachers for the primary schools. We have thus to start with fundamental primary education, and while it may well be true, as Mr. Ian Winterbottom remarked, that the most significant thing Britain has done as a Colonial Power is the creation of five university colleges, the need for education generally is, as the White Paper emphasizes, the greatest and most urgent of social and welfare needs; and it has already absorbed some £21.4 million of Colonial Development and Welfare Funds, of which £11 million has gone to university, technical and vocational education.

One suggestion made in this debate, by Mr. P. Williams, was that some attempt should be made to influence the balance of studies among students coming to Britain in the direction of engineering, agriculture, and other fields where experts are most needed, as against law and other professions not of such primary importance. The other major suggestion, made by Mr. A. Creech Jones, was that more care should be taken to avoid piecemeal schemes in Colonial development, and that it might prove possible to associate the economies of the Colonial Territories more closely with that of Britain. That, of course, is essentially the idea behind technical assistance and the Point Four Plan, and the report

* Colonial Office. Colonial Development and Welfare Acts. Report on the Administration and Use of the Funds provided under the Colonial Development and Welfare Acts. Pp. 32. (Cmd. 9375.) (London: H.M. Stationery Office, 1955.) 1s. net.

on the Colonial Development and Welfare Acts, like the annual report on Colonial research or on the Colonial territories, shows that much is already being done in this direction. Indeed, for those familiar with the latter reports, there is no need to recapitulate the admirable summary of the working of the Acts contained in this recent report.

Much has already been done to co-ordinate research activities and to avoid duplication of effort in the Colonial territories and in the United Kingdom, while pools of scientists, based on the appropriate United Kingdom scientific institutions, have also been formed to provide expert advice to Colonial governments on specific problems. It may be, however, that something more is yet required in order that the limited man-power at our disposal may be deployed most advantageously and effectively from the Commonwealth point of view. Shortage of man-power is not the only reason for difficulty in obtaining the right men. Lord Ogmore, indeed, suggested that the chief reason for that difficulty is that technicians and professional men have become rather chary of taking service in some Colonial territories that have acquired a measure of self-government. He also referred to the hope expressed by Ministers of the Northern Nigerian Regional Government that administrators and technical officers released and available from the Sudan would find important opportunities for service in Northern Nigeria. While Ministers in other territories also might welcome an increasing flow of technical assistance in this and other ways, that flow would certainly be facilitated by the formation of an international or Colonial cadre or pool such as has been suggested. Possibly it would prove easier also to adjust the British contribution to the competing demands made on Britain's scientific and technical man-power. Lord Tweedsmuir also touched on a point of critical importance in this connexion. In spite of the great demand for the best men in the United Kingdom, it is remarkable how seldom experience in the Colonial territories is of assistance in obtaining employment in Britain. Under present conditions, there must be the opportunity of returning to Britain, or the outflow of technical experts will dwindle long before the facilities for technical education in the Colonies have developed sufficiently for the territories themselves to provide the technicians they require. Quite apart from this, the scientific and technical expert returning from the Colonial territories or some other underdeveloped part of the world can make an important contribution towards educating the community in Britain to understand the needs and problems of the Colonial territories. Considerable as may be the difficulties in developing even a Commonwealth service, much more an international service, the attempt is worth making, nor would it appear that financially the cost of doing so should be excessive. No actual figures were quoted in the debates or in the White Paper, except that the Earl of Munster gave 452 as the number of research officers now employed by the Colonial Office.

Even allowing for the present serious shortage of qualified scientists and technologists and the com-

peting calls of industry and other government departments, it would not appear that, when a reasonable balance has been struck between supply and demand, the numbers of scientists and other technical experts involved need be very large. The debates, however, give further point to the inquiry into the use of scientists and technologists now being made by the Government and which the Federation of British Industries has suggested to its own members. It emphasizes also the urgency of measures for dealing effectively with the shortage of science teachers both in the short term and in the long run; and above all the importance of taking stock at a high level of the implications of Colonial development and welfare and technical assistance in general for the scientific and technical man-power of the United Kingdom.

TROPICAL SOILS AND THEIR ORIGINS

Tropical Soils

A Critical Study of Soil Genesis as Related to Climate, Rock and Vegetation. By Prof. E. C. J. Mohr and Prof. F. A. Van Baren. Pp. 498+4 plates. (The Hague and Bandung: N.V. Uitgeverij W. Van Hoeve; London: Interscience Publishers, Ltd.; New York: Interscience Publishers, Inc., 1954.) 61s.

THIS new text-book on tropical soils, beautifully printed and well illustrated, reminds one in many places of Prof. E. C. J. Mohr's well-known treatise, "The Soils of the Equatorial Regions, with Special Reference to the Netherlands East Indies", which is one of the earlier classics of tropical soil science. As the title of the present book indicates, it follows the developmental trend: soils are the result of the interaction of external factors and parent materials. As is pointed out in the introduction, consideration has only been given to those essentials which have some direct bearing on the problem. Subjects such as erosion, fertility, irrigation and drainage have deliberately been avoided, unless they have a direct influence on the soil formation; these subjects, it is stated, will be dealt with in a second volume, to be entitled "Tropical Soils and Crops".

Both authors spent several years studying soils in the former Dutch East Indies, so it is only natural that much of their factual evidence consists of Indonesian climatological and pedological data, which are both rather specialized. Indeed, on the South American and African continents, which make up most of the tropical soils of the world, maritime climatic conditions are very limited, and volcanic parent materials are not so common. On the other hand, it is a fact that, until very recently, the better-known tropical regions were those easily accessible from the sea, and the best-known soils there were the more fertile patches that are often derived from volcanic or closely related basic material. It must be admitted that not many tropical countries can offer such a wealth of accurate information as Indonesia.

Of all the pedogenetic factors involved, the authors attach by far the most importance to climate and parent material. The opening chapter, which is devoted to climate, comprises about one-fifth of the whole work, and this and the following six chapters,

dealing with rocks, their composition, their catamorphism under tropical conditions and their weathering products, complete more than half the book. Chapter 7 (twenty pages) is the only one entirely devoted to organic matter; then three chapters on genetic conceptions of soil formation, and five chapters in which a number of better-known tropical soils and their classification are discussed, complete the volume. One might conclude from this that the book shows some serious gaps. One must not forget, however, that this is a 'critical' study, and that, of the limited material available, probably much had to be discarded. Tropical soil science is still in its early stages, and the apparently neglected fields are, in fact, those that cry out most urgently for more investigation, as the authors frequently suggest. Apart from these few criticisms, the book is, in my opinion, a very good introduction to the subject for students in tropical soils.

In the first chapter, a selection of meteorological data from different regions of the world gives a fine illustration of typical tropical climate characteristics, such as rainfall distribution, different types of rainfall, rain intensity and dew formation. Reference is given to recent work by Thornthwaite and Penman on evaporation and evapo-transpiration. The rational classification of world climates, as proposed by the former author, receives only little space, but attention is redirected to Mohr's earlier classification, based on the number of wet (more than 100 mm.) and dry (less than 60 mm.) months.

The chapters devoted to rocks, their weathering and weathering products begin with a good review of fundamental soil mineralogy. While discussing the specific influence of climate on rocks, it is pointed out first that the present-day overhead climate is a much over-estimated factor and then that the grouping of tropical soils on a climatic zonal basis will inevitably be attended by various intricate complications. This statement is very pertinent, especially for the African continent, where more and more evidence is being gathered for very recent climatic variations. The chapter specifically devoted to tropical rock weathering gives a review of the more serious work done on this most promising subject, and is followed by a discussion on clay mineral formation.

As Prof. F. A. Van Baren is an authority on mineral associations in volcanic soils, a good outline is given of mineralogical work on such material. In young soils, such as volcanic ashes, this study may indeed be of real diagnostic significance for assessing the potential fertility; for older soils, the study of unalterable minerals may provide some indication as to the parent materials from which they were derived. To the discussion of granulometric data, one might add the two rather striking features found all over Africa in many old soils: the low percentage of silt-size minerals; and the presence of what might be called 'pseudo-silt' or silt-size water-stable aggregates of finer material, cemented by iron or aluminium oxides.

In their developmental conception of soil formation, the authors consider temperature, water movement, air in the soil, time and weathering stages, parent material and organic matter as the principal distinguishing features of tropical weathering. By translating each of these into a number of symbols, a given soil can be represented by what the authors call a "genetic formula"; for example, *Vb, Ho, DD, ae* means a soil formed from basic volcanic

material, deposited in hot wet lowlands, with continually descending water movement, and well aerated. This genetic conception is then applied to the different Indonesian soils, mostly of volcanic origin. This part of the book is a most valuable contribution to the study of tropical volcanic soils, and sets a pattern for future work on similar soils in other parts of the tropical world.

A good and up-to-date chapter on laterite and lateritic soils is followed by a shorter one on the still much-discussed tropical podzols. Another is devoted to the so-called Margalitic soils, a name proposed for grouping the black tropical and subtropical soils, hitherto designated under various names, ranging from black cotton soils to Regur, Rendzina and Tirs. Many of these soils are still badly defined, but several seem to have a great potential fertility if properly treated. Finally, the authors discuss a series of soils, most of them also ill-defined, known as desert soils, alkali soils, steppe and savannah soils, plain soils, plateau soils, hardpan soils, limestone soils and Ando soils. In the final chapter, devoted to soil classification, the authors discuss some of the older classification systems, including Milne's catena conception. They give their opinion on nomenclature and on the different ways of describing tropical soils. According to them, high priority should always be given to the genetic trend when establishing a general classification system; the climatological grouping of zonal, intrazonal and azonal should be dropped, the terms 'type' and 'series' should be reconsidered, and profile types should be used as basic units for classification purposes.

This book can be warmly recommended; but it is to be hoped that in a new edition more attention will be given to pedological work in Africa, where great progress has been made during the past ten years, as may be seen from the increasing number of papers in English, French and Portuguese now available.

J. D'HOORE

MATHEMATICAL ANALYSIS

Theory of Functions of Real Variables

By Prof. Henry P. Thielman. (Prentice-Hall Mathematics Series.) Pp. xiii+209. (London: Butterworths Scientific Publications, 1953.) 35s. net.

Principles of Mathematical Analysis

By Walter Rudin. (International Series in Pure and Applied Mathematics.) Pp. ix+227. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 40s.

THE distinctive features of Prof. H. P. Thielman's book, "Theory of Functions of Real Variables", which is intended to follow a course in advanced calculus, is the emphasis on the postulational approach and on the theory of sets. The first chapter treats positive integers as defined by Peano's postulates and proceeds to rational, irrational, algebraic and transcendental numbers, discussed in relation to sets, groups and fields. Then follow three very lucid chapters containing a good deal of information about sets and abstract spaces. Chapters 5 and 6 deal with functions on sets, and with a discussion of limits and continuity in connexion with Hausdorff spaces. Chapter 7 is more elementary than the rest of the book. It gives the usual tests for convergence of infinite series, which are generally studied at an earlier stage. Chapters 8 and 9 give a clear exposition of measure and of integration in the sense of Riemann,

Lebesgue, Riemann-Stieltjes and Lebesgue-Stieltjes. Finally, Chapter 10 discusses absolute continuity, the indefinite integral over sets, and derivatives. There are about two hundred problems distributed throughout the text. In order to cover as much ground as possible, the author has relegated many minor theorems to this set of problems to be solved by the student. Presumably, if the student cannot himself supply the proofs of these minor theorems, he must refer to the larger treatises recommended at the ends of several chapters. The book concludes with a copious index.

Dr. W. Rudin's "Principles of Mathematical Analysis" has much in common with Prof. Thielman's book, and covers, more concisely, nearly the same ground, with some additions. However, Dr. Rudin claims that, except for a few facts about determinants, his treatment is self-contained, the main requirement being the reader's ability and inclination to pursue an abstract train of thought. The first chapter deals with the real and complex number systems. Chapter 2 compresses the elements of set theory into eighteen pages. The simpler properties of the convergence of real and complex sequences and series are given in Chapter 3. Subsequent chapters, except for a brief reference in Chapter 6, deal only with the real variable. Chapter 4 discusses limits and continuity, and Chapter 5 the mean value theorem and related theorems, including Taylor's. Chapter 6 introduces the Riemann-Stieltjes integral, while Chapters 7 and 8 return to the discussion of series, and include uniform convergence, equicontinuous families, Fourier series, and some recent work by Stone generalizing a theorem of Weierstrass. Chapter 9 gives some of the leading theorems about functions of several variables, including a discussion of Jacobians and functional dependence. Chapter 10 gives an unusual treatment of Lebesgue integration, based on an additive set function—a generalization of the usual Lebesgue measure—in a space more general than that usually considered. It is claimed, not altogether convincingly, that this departure from the usual treatment brings out the essential features with greater clarity.

There are more than a hundred and thirty miscellaneous problems at the ends of the chapters, with hints for the solution of the more difficult. Simpler examples occur in the text, including some which show how theorems just proved may fail if the conditions are relaxed. The book concludes with a short bibliography, a list of symbols and an index. It has many merits for sufficiently mature students.

H. T. H. PIAGGIO

MODULATION AND INFORMATION THEORY

Modulation Theory

By Harold S. Black. (The Bell Telephone Laboratories Series.) Pp. xii+364. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 65s. net.

THIS book is a recent addition to the Bell Telephone Laboratories series and is, in fact, the twenty-eighth volume of the series. The term modulation has come to represent in the most general as well as in the most specific sense any process whereby a message is translated into information-bearing signals for purposes of transmission and by which

the signals reproduce the message at the receiving end. Direct long-distance communication became practicable with the development of the science of electromagnetism, and the theory and practice of modulation in the sense in which the term is used to-day thus began with telegraphy a little more than one hundred years ago. Some of the concepts now recognized as having fundamental significance appeared quite early in the history of telegraphy; but it was not until radio and multi-channel line communication were beginning to establish themselves on a major scale in the early 1920's that the quantitative generalizations which now form the basis of communication theory began to be enunciated. With the increasing practical importance of the effect of 'noise' on communication resulting from the power to amplify to an almost unlimited extent, the theory of signalling in the presence of noise was already well advanced at the outbreak of the Second World War. Radar, however, presenting the signal-to-noise problem in an extreme form, served as the spur for a spectacular advance in the theory of signalling in the presence of noise, and the statistical theory of communication, evolved by Shannon on the basis of the fundamental quantitative concepts postulated by Hartley some twenty years earlier, was disclosed in a series of publications in the years immediately following the War. This new quantitative theory of information now constitutes an essential background to the theory of modulation in communication systems.

Dr. H. S. Black's book is the first, so far as the present reviewer is aware, to present a comprehensive treatment of modulation based on the concepts and quantitative results of information theory. The first eight of the twenty chapters of the book treat the general considerations underlying systems for the communication of information. After a brief but most informative review of the historical background, consideration is given to the purposes served by modulation and to the kinds of modulation which are employed. One full chapter is directed to the sampling principle and another to quantization, code transmission and multiplexing. In these chapters important basic concepts—for example, the requirement to sample at a rate slightly greater than twice the highest significant signal frequency, and the possibility of the regeneration with complete fidelity of a quantized signal provided the peak interference is less than half a quantum step—are developed with great clarity.

In a chapter entitled "Efficient Systems of Communication" are treated Shannon's central theorem of information theory and the law governing the exchange of band-width for signal power. The concept of the quantitative measure of information is developed, the term entropy is introduced and consideration is given to the efficient encoding of English text. The chapter closes with an interesting comparison of the possible performance of existing systems with the unsurpassable transmission rate determined by Shannon's central theorem. The next two chapters deal with speed of signalling, channel capacity and the possibility of reducing signal power by the use of redundant codes.

These fundamental considerations occupy more than one-third of the text of the book. Twelve chapters follow in which the various forms of modulation receive detailed treatment. Amplitude and frequency modulation are followed by pulse modulation, there being separate chapters on pulse

amplitude, pulse duration and pulse position, modulation, and finally there are two chapters on pulse code modulation systems. The treatment is clear, and simplifications and assumptions are stated with exceptional care. It is the chapters on pulse code modulation which form the most interesting single section of the book, for these furnish an outline of the principles of a system which must be expected to have a profound effect on the future development of long-distance communication. In addition to explaining the principles of multi-channel pulse code modulation, a description is given of a twelve-channel system which employs electron-beam coders and decoders. The final chapter of the book, Chapter 20, deals with the problem of 'distributed' channels, that is to say, systems in which a multiplicity of transmitters has access by a common transmitting medium to any of a similarly numerous group of receivers. The special problems associated with this type of transmission are illustrated by reference to a mobile system.

This book gives a comprehensive treatment of the whole problem of modulation in communication systems, and the treatment is based on the fundamental concepts of information theory. The standard of mathematics required is well within the scope of a university undergraduate course in physics or engineering. It is an especial merit of the work that the subject has been treated on a very general basis, and at the same time investigated in detail in its various branches, without recourse to mathematical methods of a standard beyond that of undergraduate courses. The very success of the treatment evokes the question as to whether it would not have been possible to give an outline of the derivation of Shannon's central formula in the theory of information. This volume is a worthy addition to the series of distinguished text-books which are associated with the Bell Laboratories.

JAMES GREIG

PLASTIC DEFORMATION OF CRYSTALS

Dislocations and Plastic Flow in Crystals

By Prof. A. H. Cottrell. (International Series of Monographs on Physics.) Pp. x+223+8 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 25s. net.

PROF. A. H. COTTRELL'S book is an admirable account of the theory of dislocations as applied to the plastic deformation of crystals, and is a valuable starting-point for students of this subject. It is written in an easy and attractive style, with the mathematical treatments outlined but not given in detail; and if there is occasionally a tendency to treat as fact things which have been assumed, or are suggested by somewhat imperfect experiments, this is generally done for the purpose of simple exposition, and the reader need not be misled.

The book begins with an account of the deformation of crystals by slip, and the way in which it is described in terms of the movement of edge and screw dislocations. It then deals with the theory of dislocations in a perfectly elastic isotropic and structureless medium, from which are derived the equations governing the stress field of a dislocation, its strain energy, and the forces between dislocations. The periodic structure of the crystal is next introduced,

leading to a discussion of the forms taken by dislocations in crystals, the forces necessary to move them, and the special forms of dislocation that may exist in face-centred cubic, body-centred cubic and hexagonal crystals. Growth spirals in crystals, the Frank-Read source, and the grain boundary, considered as an assemblage of dislocations, are dealt with in this chapter. This chapter and the preceding one are the most permanently valuable part of the book, and will frequently be referred to.

On proceeding to the explanation of the observed behaviour of actual crystals, the book tends inevitably to include a number of speculations, some of which may prove to be short-lived. The number and distribution of dislocations in unworked crystals are considered, with results that direct attention to the uncertainty of present knowledge of these basic facts. The piling of dislocations behind an obstacle, the grain boundary as an obstacle to moving dislocations, the action of dissolved atoms and precipitated particles, and the explanation of the sharp yield-point in some metals in terms of the influence of atmospheres of solute atoms around dislocations are described; but it becomes clear that the mathematical development of the theory has run far ahead of knowledge of the values of the terms appearing in the equations.

In the final chapter, which deals with work-hardening, annealing and creep, great stress is placed on the phenomenon of easy glide. This prepares the way for the author's view that work-hardening is primarily due to the mutual interference of dislocations moving in intersecting planes. This view is plausibly and effectively argued, without neglecting other views that have been expressed. The phenomena of recovery, polygonization and recrystallization prove to be too complex to be more than briefly described, and in selecting for discussion mainly those investigations in which quantitative treatments of the processes have been attempted, the author has produced a picture that appears rather strange to the practical metallurgist. The treatment of creep, on the other hand, is very acceptable, for while it presents a picture of the right general kind, it avoids the temptation to set up a master equation from which all things can be deduced, and keeps a proper balance between the deformation of the crystal and that of the grain boundary. Possibly too much importance is given to exhaustion theories of creep, and the reader is allowed to escape with the impression that, but for the presence of regions of exceptionally easy slip, materials would creep at a uniform rate, which is almost certainly not the case.

Dislocation theory moves so fast that, in spite of efforts to incorporate the results of new investigations up to the time of writing, some things are missing that would have to be included if the book were re-written to-day. Vacancies are mentioned; but little indication is given of the importance they have assumed, rightly or wrongly, in all recent discussions of processes in crystals, and no attention is given to the influence of vacancies formed during plastic deformation on the speed of diffusion processes, and their consequent influence on many of the phenomena discussed in the book. Nevertheless, all workers in solid-state physics will find Prof. Cottrell's work an invaluable guide, far in its treatment of alternative points of view, stimulating and informative, but not to be regarded as final. Rather it will raise innumerable questions and suggest new investigations to improve the understanding of the strange behaviour of crystals.

N. P. ALLEN

A Simple Guide to Modern Valency Theory

By G. I. Brown. Pp. ix+174. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1953.) 12s. 6d. net.

THE author of this book, a master at Eton College, in framing this concise account of modern ideas on valency acknowledges his debt to the writings of Sidgwick and Linus Pauling. His early chapters contain a good account of the history of valency and of its classical conception. Then follow chapters severally dealing with the covalent, electrovalent and dative bonds and with experimental methods of investigating these linkages. In these chapters Mr. Brown explains clearly and adequately the modern ideas more fully than in the ordinary advanced text-book of chemistry.

Dr. L. E. Sutton, himself a well-known worker in this field, says in the foreword: "present day valency theories concern a very wide range of phenomena... [and] cover the whole discussion of potential energy and configuration for atomic, molecular, and inter-molecular systems". This conception of the place of valency accounts for chapters on internal dimensions of crystals and molecules; simple examples of resonating molecules; hydrogen and the hydrogen bond; and molecular orbitals. These chapters are well written, and the new terms and ideas are carefully explained by a writer who obviously has a grip of his subject. Nevertheless, I believe that more applications of the new knowledge would improve the book. The theory of molecular orbitals has been used advantageously in promoting an understanding of bonding in organic molecules. The author devotes a whole chapter to this theory, but uses it only to explain why oxygen is paramagnetic. Again, the preface states that the book is intended for sixth-form pupils and for older chemists interested in modern developments. Teachers among these 'older chemists' will be disappointed to find that the author touches but lightly on the time-honoured valency difficulties connected with nitric oxide, carbon monoxide and hydrogen peroxide; also, they will find no answer to the alert sixth-former who asks why does the atom of copper procure valency electrons from the penultimate shell? Still, this is a minor criticism; the author has written a good concise account of modern valency. G. FOWLES

Introduction to Tensors, Spinors, and Relativistic Wave-equations

(Relation Structure.) By Prof. E. M. Corson. Pp. xiii+221. (London and Glasgow: Blackie and Son, Ltd., 1953.) 55s. net.

QUANTUM theory of fields has developed along two main lines: one concerning itself with the mathematical basis of the subject; the other, more particularly with the relation of its predictions to experiment. In this volume, Prof. E. M. Corson addresses himself to a unified survey of the first development.

The book starts with a review of tensor and spinor analysis. The canonical formalism and the conservation laws of field theory are considered next, followed by a chapter on relativistic wave equations. The climax of the theoretical development comes with the fifth chapter, where the basis of the theory is sought in abstract algebra and group theory. In the author's words, "here the physicist may find the answers as to how and why a particular covariant formalism is suitable for the description of particles

of given spin, and how and why the so-called field aspect of given genus of particles is related to the so-called particle aspect".

The book is by no means easy to read, for considerable familiarity with the concepts of modern algebra is assumed. But to read through with Prof. Corson is an adventure of discovery—a discovery of some of the profoundest ideas in theoretical physics, presented with rare understanding and logical clarity. There is no mention of developments after 1947—possibly, with a gain in the permanent value of the book.

ABDUS SALAM

The Chemical Structure of Proteins

Edited by G. E. W. Wolstenholme and Margaret P. Cameron. (A Ciba Foundation Symposium.) Pp. xii+222+6 plates. (London: J. and A. Churchill, Ltd., 1953.) 25s. net.

THIS is a record of a Ciba Foundation Symposium held in London in December 1952. It contains about seventeen papers by recognized authorities and verbatim reports of very frank and illuminating discussions on them. The volume thus contains much interesting reading for all who are interested in protein structure. One might, however, be tempted to question whether publication of these symposia, however interesting they may have been, is in every case necessary. For topics which are not frequently reviewed there is much to be said for publication; but in a much-cultivated field like the structure of proteins, in which three symposia were held within a short period, to a considerable extent with the same participants, which have all been published, there is a good deal of overlapping.

One can sympathize with the desire of the organizers and participants of such conferences to see their news and views dispersed as widely as possible; and readers who have time will undoubtedly find much that is of great interest. But the burden of coping with all such reports is becoming very great, and organizers might try to ensure that the collection they offer will be to a reasonable extent unique.

J. B.

Weed Control in Farm and Garden

By Stephen J. Willis. (Agricultural and Horticultural Students Series.) Pp. 184+6 plates. (London: Vinton and Company, Ltd., 1954.) 8s. 6d. net.

IT is several years since the appearance of any British book which deals with all aspects of weed control, so that this small volume will be welcomed not only by the students to whom it is primarily addressed but also by many farmers and growers. Although the emphasis is essentially practical, sufficient discussion of basic principles is included to permit intelligent application of control methods, and the result is a well-balanced account of modern techniques.

The first four chapters are concerned with the biology of weeds and the role of hygiene and cultural practice in their prevention. In the main body of the text available chemicals are described, weed responses tabulated and recommendations given for treatment of the various agricultural and horticultural crops. Spraying and dusting machinery is briefly discussed, and special methods for the control of certain perennial weeds and cryptogams outlined. Common and scientific names of weed species and formulae of herbicides are listed in appendices, while technical terms are explained as they occur. There is a good index, and the price seems very reasonable.

CLOUD CHAMBER AND ASSOCIATED TECHNIQUES

DURING the past few years there have been several important developments in techniques for the study of the paths of ionizing particles in gases and liquids. The diffusion chamber has now become almost a standard instrument for use with large accelerators, while the Glaser bubble chamber is exciting ever wider interest. The use of large numbers of metal plates in the Wilson chamber has greatly increased its usefulness in many applications, and an increased effort has gone into the operation of Wilson chambers under conditions of high gas pressure. Some of these techniques have been developed specifically for use in cosmic ray applications, while others have been used almost exclusively in association with high-energy particle accelerators. With the commencement of the operation of several such accelerators in Great Britain and the planning of larger ones, the time appeared ripe for an assessment of the relative merits of these various types of particle track detection and of their respective fields of applicability.

In order to discuss these questions, a conference on "Recent Developments in Cloud Chamber and Associated Techniques" was held in the Physics Department at University College, London, during March 24-26. Prof. H. S. W. Massey, opening the conference, outlined the considerations that had led to the decision to convene it in association with the Physical Society. A message of good wishes to the conference from Prof. C. T. R. Wilson, now living in retirement near Edinburgh, was heard with enthusiasm, and it was agreed unanimously to convey to Prof. Wilson the good wishes and respect of those present. Prof. P. M. S. Blackett, taking the chair for the first session, said that in planning a research programme one has to try to envisage the probable scope of research in five or ten years time. Conferences of this kind bring out the direction of development of technique and enable one to decide where the major effort can most fruitfully be placed.

Dr. M. Snowdon (Atomic Energy Research Establishment, Harwell) reviewed the development of the diffusion chamber from the early researches of Langsdorf and Cowan to the more recent work of Shutt, and then went on to describe in some detail the 16-in. diameter diffusion chamber that has now been operated for some time in conjunction with the 150-MeV. synchro-cyclotron at Harwell. In a most illuminating paper on the theory of operation of the chamber, Dr. A. Ghig (Genoa) discussed the factors determining the shape of the sensitive layer and the extent of the insensitive zone near the walls of the chamber. Experience with diffusion chambers in conjunction with the high-energy accelerators now operating in Great Britain was then described by workers from Liverpool (Dr. W. H. Evans, Miss M. H. Aston), Birmingham (Dr. L. Riddiford) and Glasgow (Dr. J. R. Atkinson).

From these and subsequent contributions it was clear that the main advantages of diffusion chambers are their continuous sensitivity and simplicity of

construction. The recovery time after the passage of about 100 particles or fewer is of the order of 30 sec., while, even when the full beam of the Liverpool synchro-cyclotron (10^{10} particles) is passed through, the recovery time is only 3 min. The rapid recycling of the diffusion chamber makes it a very suitable tool for operation with pulsed sources of fast particles from machines, and they can readily be operated at pressures up to 25 atmospheres in hydrogen or 15 atmospheres in helium. They suffer from a number of disadvantages, however, such as the shallowness of the sensitive layer and the indefiniteness of its extent and shape. These severely limit the usefulness of the diffusion chamber in cosmic ray investigations. In addition, the time of drop-growth (0.1-0.2 sec.) is long, so that track distortion may be serious, a point which emerged from measurements described by Dr. N. Cusack (Birkbeck College, London) in which two photographs of diffusion chamber tracks were taken separated in time by 0.3 sec.

The second session opened with a review of the technique of the multi-plate chamber by Prof. C. Peyrou (Berne). Apart from the obvious advantage of giving a high yield of particles that stop in the chamber, the plates make possible certain technical improvements in chamber operation. Large clearing fields can be employed between the plates, and this facilitates the use of very deep chambers, while the recovery time is short. With such deep chambers, however, particular attention has to be paid to the damping of the motion of the piston in order to avoid non-uniform expansion throughout the chamber. Distortion is also particularly liable to occur near the plates. Questions of range and scattering in the plates of a multi-plate chamber were described by Drs. F. Muller (École Polytechnique, Paris) and A. W. Wolfendale (Manchester), respectively, while Dr. B. Gregory (École Polytechnique, Paris), in describing the operation of a momentum-measuring chamber (with magnetic field) in association with a multi-plate chamber, stressed the supreme importance of temperature control for accurate work. With temperature control to the nearest 0.1 deg. C. a maximum detectable momentum of 16 GeV./c is attainable.

The conference then passed to the consideration of recent techniques for the control of cloud chambers using scintillation and Čerenkov counters. Dr. B. D. Hyams (Manchester) considered that scintillation counters have no particular advantage over gas proportional counters in fast-particle selection systems; but their use in conjunction with Čerenkov counters permits the selection of slower particles in a definite velocity-range, and an account of experience in this field was given by Dr. D. M. Binnie (Manchester).

In the third session of the conference, experience gained in the operation of a high-pressure cloud chamber filled with argon at a pressure in the neighbourhood of a hundred atmospheres was described by members of the joint cosmic-ray group from University College, London, and from the University of

Edinburgh (see also *Nature* of March 12, page 445). Dr. G. R. Evans (Edinburgh) reviewed the progress made in the operation of high-pressure cloud chambers since his first experience of the technique some sixteen years ago. One of the main difficulties associated with the operation of these chambers is the onset of non-uniform vapour condensation after a few expansions, arising from the establishment of a temperature gradient in the gas which hinders the re-circulation of alcohol vapour to the top of the chamber. Dr. N. Morris (London) described a study of these temperature gradients, while Mr. H. S. Tomlinson (London) discussed the design of 'overcompression' systems for a high-pressure cloud chamber employing a hydraulic control system. Problems associated with the identification and measurement of tracks in high-pressure cloud chambers were discussed by Dr. E. H. S. Burhop and Mr. F. R. Stannard (London) and by Mr. E. J. Williams (Edinburgh), an investigation of distortion in such chambers was described by Mr. P. Baxter (London), and experience gained in their operation (with deuterium filling) in conjunction with the proton beam of the Harwell cyclotron was reported by Dr. T. C. Griffith (London).

The high-pressure cloud chamber possesses the advantage of a great increase in the rate of gas interactions over the conventional Wilson chamber operated at atmospheric pressure. Its sensitive time is long (of the order of 1 sec.); it can operate at pressures much higher than the diffusion chamber, and measurement of multiple scattering and width facilitate particle identification. However, its usefulness in high-altitude cosmic-ray investigation, and particularly in association with high-energy accelerators, depends on the success achieved in reducing the present recycling time of 10–15 min. by means of overcompression or fast recompression.

A return to the discussion of the applicability of overcompression and fast recompression techniques was made in the fourth session, when Drs. N. C. Barford (Imperial College of Science and Technology, London), J. Walker (Birmingham) and J. R. Atkinson (Glasgow) described their experience in the application of the technique to chambers operating near atmospheric pressure. Although it appears that with this technique it is not possible to accomplish the ideal aim of re-evaporating drops before they have had time to fall far after an expansion, it does seem practicable to reduce the recycling time by a factor of 5–10.

The greater part of this session was devoted to a discussion of the bubble chamber. Dr. C. Dodd (University College, London) reviewed the development of this new technique. A considerable amount of experience is now available on the use of pentane and liquid hydrogen in such chambers. Apart from the high density of the operating fluid—an advantage which it shares with the high-pressure cloud chamber—the bubble chamber is characterized by a rapid rate of bubble growth, so that distortion due to liquid motions is likely to be small. Another advantage is the absence of background due to old tracks. Bubble chambers have come to be classified into two types: the smaller 'clean' chamber contains no plane surfaces, no boiling occurs until an ionizing particle passes through, and the rate of bubble growth is very rapid; large 'dirty' chambers, with plane metal walls and glass windows for illumination and photography, which boil continuously at corners and at metal-

glass boundaries, but the rate of bubble growth may be up to a thousand times slower than in a clean chamber. As a result, the central portion of a 'dirty' chamber remains in a sensitive condition for a few milliseconds after removal of the pressure, and this means that quite large bubble chambers of this type can be operated effectively in conjunction with particle accelerators; such a chamber operating with 15 gallons of liquid hydrogen is being constructed at the University of California, Berkeley. Great interest was aroused by the reading of a paper submitted by D. Parmentier and A. J. Schwemin, of Berkeley, which arrived two days before the conference and showed pictures of meson tracks from the Berkeley bevatron taken with a liquid-hydrogen bubble chamber.

Prof. G. Martelli (Pisa) discussed some theoretical aspects of the operation of the bubble chamber, while the construction of a bubble chamber designed to test the applicability of the method to cosmic ray investigations was described by Prof. P. Bassi (Padua). For cosmic-ray applications the bubble chamber faces severe limitations, because counter control cannot be used to put the chamber into a sensitive condition. But if the sensitive time could be extended so that the chamber remained sensitive for a large fraction of the total time, it would need to be considered seriously for cosmic ray work. There seems some prospect of achieving this by operating at increased temperature and by care in selection of the material of the metal walls of the chamber. The bubble chamber technique shows great promise; but the apparatus for large-volume chambers tends to become very complex, and little work has so far been done on the identification and measurement of bubble-chamber tracks.

The fifth session dealt with the interpretation of cloud-chamber photographs. After a review of the problems by Dr. A. L. Hodson (Leeds), important new advances in the measurement of specific ionization were described by Dr. C. A. Uttley (Imperial College of Science and Technology, London) using drop counting, and by Dr. I. Butterworth (Manchester) using a photometric method. Mr. A. L. Rodgers (Manchester) described momentum measurements with shallow Wilson chambers in conjunction with a magnetic spectrometer capable of measuring momenta up to 10^{-2} eV/c, while Dr. R. R. Rau (Princeton) described the momentum cloud chamber and reprojection system used by the Princeton group. Interesting examples of the use of internal counters to detect positron-electron pairs in a Wilson chamber were described by Dr. W. T. Davies (Oxford), and a high-frequency method of the time-marking of particle tracks was suggested by Dr. D. Gabor (Imperial College of Science and Technology, London). Suggestions of other particle track techniques were made by Mr. A. R. Bevan (University College, London) (employing high-frequency discharges localized along the tracks of ionizing particles) and in a contributed paper by Dr. C. E. Nielsen (Ohio) on a vapour cloud chamber.

When this conference was planned it was thought it would appeal to only a small group of specialists. As it turned out, the attendance exceeded one hundred and twenty. The animated discussion that followed each session and that continued in groups long after the sessions had concluded is the best testimony to the need for such a conference, which proved of great value in placing in their correct perspective these various new techniques.

E. H. S. BURHOP

MOLECULAR STRUCTURE OF DEOXYRIBOSE NUCLEIC ACID AND NUCLEOPROTEIN

By M. FEUGHELMAN*, R. LANGRIDGE, DR. W. E. SEEDS, DR. A. R. STOKES and DR. H. R. WILSON

Wheatstone Physics Laboratory, King's College, London

C. W. HOOPER and DR. M. H. F. WILKINS

Medical Research Council Biophysics Research Unit, King's College, London

AND

DR. R. K. BARCLAY and DR. L. D. HAMILTON

Sloan-Kettering Institute, New York

THE molecular structure of deoxyribose nucleic acid and nucleoprotein will probably provide the basis for chemical interpretation of genetical phenomena (cf. refs. 1-3) and of the reproduction of nucleic acids and proteins. It has been shown that deoxyribose nucleic acid has a helical structure^{4,5}, and Watson and Crick have proposed a structure involving a special type of pairing of nitrogen bases^{6,7}, and, from the structure, derived a hypothesis concerning the self-duplication of nucleic acid⁸. Information about the structure of deoxyribose nucleoprotein has been scanty (see ref. 9), and it has been suggested that deoxyribose nucleic acid may not be closely combined with protein¹⁰. This communication describes in a preliminary way X-ray diffraction and molecular model-building studies which show that a helical structure of deoxyribose nucleic acid involving the base-pairing of Watson and Crick can be used to explain very satisfactorily a large amount of observed data. It is also shown that deoxyribose nucleoprotein is definitely a compound of protein with nucleic acid. The nucleoprotein structure is derived as a step towards finding the molecular structure of chromosomes and does not at this stage necessarily suggest any ideas about biological replication, etc.

Structure of Deoxyribose Nucleic Acid

The helical nucleic acid molecule has, in the solid state, two main configurations¹²: the very compressed and highly crystalline *A* structure, and the slightly more extended helix, the *B* structure, which is often paracrystalline. Here we are concerned only with the *B* structure, which is the form in which the nucleic acid exists when combined with protein.

The approximate diameter and pitch of the nucleic acid helix were derived directly from the X-ray diffraction pattern^{4,5}, and it was clear that two or more polynucleotide chains were twisted around one another in the nucleic acid molecule^{4,5} and that the chains were bound together by hydrogen bonds between bases^{6,13}. Watson and Crick⁶ provided a special scheme for this bonding and built a molecular model.

The exact configuration proposed by them was not correct^{11,14}. This was shown by lack of agreement between the Fourier transform of their model and the observed X-ray diffraction pattern. In particular, the general diameter of their model was rather too large. It remained to be shown that it was possible to build a model which contained the

Watson and Crick hydrogen bonding and which gave the required Fourier transform. The general nature of such a modified *B* structure has already been described briefly by some of us¹¹. It has also been shown⁴ that the shape of the pair of nucleotides must

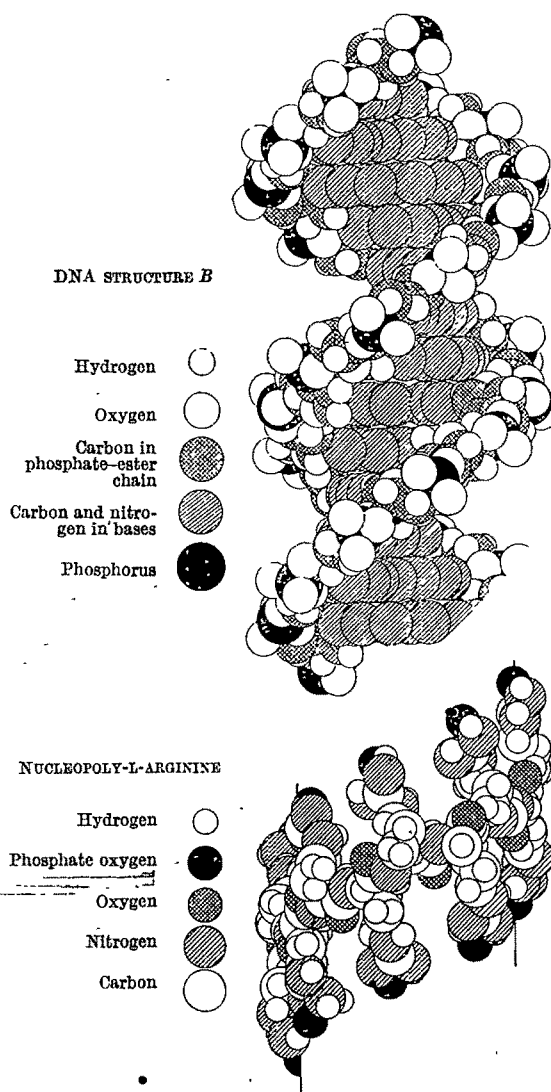


Fig. 1. Models of proposed structure of deoxyribose nucleic acid *B*, and nucleopoly-L-arginine

* Present address: Wool Textile Laboratories, Commonwealth Scientific and Industrial Research Organization, Ryde, N.S.W., Australia.

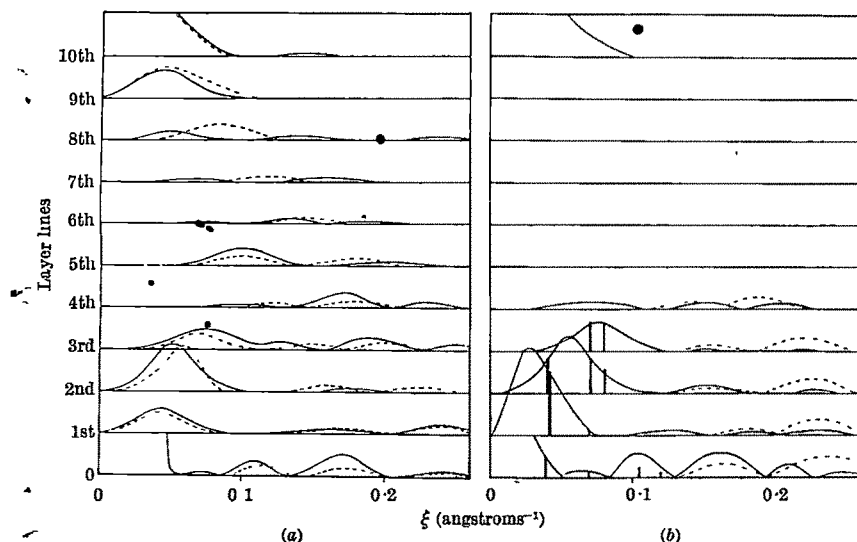


Fig. 2. Calculated and observed transforms of deoxyribose nucleic acid and nucleoprotamine: (a) The dotted curve shows the plot in reciprocal space of the observed intensities of X-ray diffraction from nucleic acid *B*. The continuous curve is the square of the Fourier transform of the proposed structure. (b) The dotted curve and vertical lines show the observed X-ray diffraction from nucleoprotamine. The continuous curve is the square of the transform of the proposed structure. (The intensity scale of the central maximum is on a reduced scale of one-tenth that of the remainder of the diagram.)

take roughly the form of a rod passing approximately through the helix axis and at right-angles to it. This is so if the pair of bases in the Watson and Crick model is moved towards the helix axis. This movement also has the desired effect of reducing the general diameter of the molecule. Furthermore, the distribution of electron density in the molecule must not alter suddenly at a given radius of the helix, but must decrease gradually near the outside of the molecule, thus reducing the magnitude of secondary diffraction maxima on the equator of the diffraction pattern. (In the *A* structure much of the electron density is concentrated at one radius¹¹.) This may be achieved if the sugar ring in each nucleotide is placed so that its plane is inclined as much as possible to the helix axis.

If such molecular models are built on the assumption that the sugar ring is non-planar as in ribose, many interatomic distances are found always to be much smaller (for example, C—O 2.6 Å.; C—P 2.9 Å.) than the usual Van der Waals values. However, it appears very reasonable to expect that the sugar ring may have a slightly different configuration either intrinsically or as a result of distortion. The polynucleotide chain will be compressed by large attractive forces between the phosphate ions and the hydrated sodium ions which are surrounded by oriented water of low dielectric constant. These forces may easily distort bond angles by a few degrees and thus may alter considerably the non-planarity of the sugar ring. It has been found that small interatomic distances can be avoided if the sugar ring is approximately planar (the only short contact being a C—O distance of 2.9 Å.). It may be expected that the interatomic distances in such a compressed chain molecule will tend to be small. The general appearance of the molecule is shown in Fig. 1. The model cannot be precise, because many bond angles and lengths are not known accurately; but the transform of the model has a close correspondence with the observed X-ray diffraction (Fig. 2).

To calculate the transform, assumptions must be made about the position of the sodium ions and of the water in the structure. The amplitude of the X-rays scattered by the sodium ions is about one-sixth that of the nucleic acid immersed in water. The *B* configuration of nucleic acid is well defined when the relative humidity of the surrounding atmosphere ranges from 85 to 95 per cent or more, and nucleoprotein gives a good X-ray pattern at 95–100 per cent humidity. As the humidity is high, it is reasonable to suppose that all available space around the molecules of nucleic acid and nucleoprotamine is filled by water. The sodium ions are probably each surrounded by about six water molecules, and the strong attraction between the sodium ions and the phosphate group will keep the Na⁺—O⁻ distance

~ 5 Å. Mutual repulsion of the sodium ions will tend to distribute the sodium ions in the direction of the helix axis, alternately above and below the phosphate chain.

Evidence for Chemical Combination of Protein and Deoxyribose Nucleic Acid

In synthetic deoxyribose nucleoprotein, made by combining nucleic acid and protamine, the ratio between the numbers of basic amino-acids and phosphate groups may be varied (see refs. 15, 16); but in sperm heads the ratio is always close to unity¹⁷, and this stoichiometric relation has been taken as evidence for chemical combination.

Deoxyribose nucleic acid is normally prepared as the sodium salt. If protein in nucleoprotein is combined with the nucleic acid, the extent of the binding may be determined by the proportion of sodium ions displaced from the nucleic acid. Flame photometry (kindly done by Mr. A. J. Rose and Mr. J. F. Becker, of the Courtauld Institute, Middlesex Hospital, London) shows that there is one sodium ion per phosphate group in our nucleic acid specimens (see also ref. 18), and that in intact sperm heads of trout, and in nucleoprotein extracted from the sperm of trout and herring, there is about one-tenth or less of this amount of total sodium and potassium.

Furthermore, it has been suggested¹⁹ that, if protein is arranged around each nucleic acid helical unit, then the sideways separation of the nucleic acid molecules, obtained by X-ray diffraction, will be greater in nucleoprotein than in nucleic acid. However, no valid evidence of this kind has been produced, because the large proportion of water in the structure has not been taken into account. Fig. 3 shows how the relevant X-ray spacings vary with relative humidity. At low water contents the molecules are closely shrunk together and are farther apart in nucleoprotein than in nucleic acid, as one would expect. Owing apparently to the hydration of the sodium ions, the nucleic acid swells markedly with

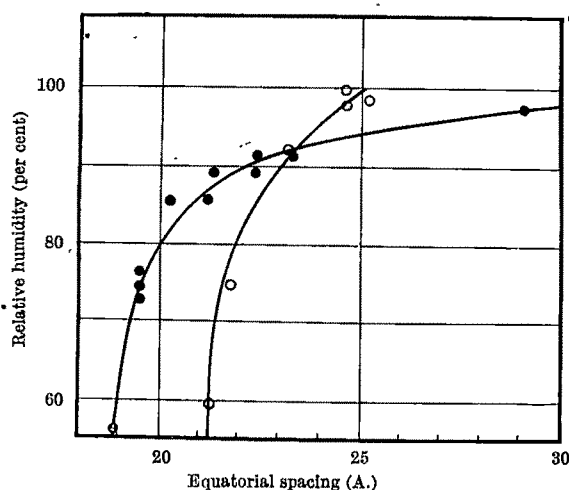


Fig. 3. Swelling of deoxyribose nucleic acid (sodium salt) and deoxyribose nucleoprotamines. Curves show the variation of equatorial spacing with humidity.
●, Nucleic acid; ○, nucleoprotamine

increasing relative humidity of the surrounding atmosphere and finally dissolves. The nucleoprotein swells much less and is insoluble in water. At about 92 per cent relative humidity, the X-ray spacings are equal for nucleoprotein and nucleic acid, and the water contents per 100 parts by weight of nucleic acid are respectively 52 and 95. This difference of water content is about that which one would expect if the protein were between the nucleic acid helical units and presumably bound to them.

The general appearance of the X-ray diffraction pictures of deoxyribose nucleic acid and nucleoprotamine is very similar⁴; but a difference of molecular structure is definitely indicated by the fact that the first layer line on the nucleoprotein picture is appreciably stronger than that for nucleic acid. Again, deoxyribose nucleoprotein always occurs in a hexagonal crystalline form, but nucleic acid occurs either in a different hexagonal form or partially paracrystalline. This difference of lattices, resulting from a different packing together of molecules, indicates a difference of shape of nucleoprotein and nucleic acid molecules.

Molecular Models of Nucleoprotamine

A protamine molecule is believed to consist of one polypeptide chain, with about two-thirds of the amino-acid residues arginine¹⁷, in which groups of four consecutive arginines frequently occur. The only way in which we have been able to arrange polyarginine with respect to deoxyribose nucleic acid so that the basic end-groups of the side chains are close to the phosphate groups is to wrap the fully extended polypeptide chain helically around⁸ the nucleic acid helix. (No water was introduced between the phosphate and guanidinium groups.) The repeat distance along the fully-extended polypeptide chain is equal to the separation of the nucleotides along the polynucleotide chain, and the distance between the ends of the successive side-chains pointing in opposite directions is equal to the separation, in the helix axis direction, of the two phosphate helices on the nucleic acid molecule (see Fig. 1). In this way the poly-arginine part of protamine may be combined with deoxyribose nucleic acid without distorting the

nucleic acid molecule. Such a nucleopoly-L-arginine structure gives the observed increase of intensity of the first layer line of the nucleoprotamine X-ray picture relative to that for deoxyribose nucleic acid (Fig. 2). Studies of protamine have suggested¹⁸ that the non-basic residues may be distributed in all of the molecular components and, as each phosphate appears to be combined with an arginine in nucleoprotamine, it seems desirable to be able to accommodate non-basic residues in the nucleoprotamine structure while permitting all arginines to combine as above with phosphate groups. This will be so if the non-basic groups are introduced as loops in the polypeptide chain between two arginines. It is not possible to form such a loop with a single residue; but, if two non-basic residues occur together, a suitable loop may be formed. Sequence analysis of protamine^{17,20} shows that non-basic residues do occur almost entirely in pairs, and hence it may be supposed that this rather special feature of the amino-acid sequence is explicable in terms of nucleoprotamine structure.

Density and Water Content Measurements

The correspondence between the observed X-ray diffraction patterns and the intensities calculated from the proposed structures is good (Fig. 2), and the ability to account for both the nucleic acid and nucleoprotein data makes the proposed structure especially convincing. Density and water-content measurements, however, do not agree well with the proposed structures; but such disagreement is not uncommon when the structure of fibres of biological material is considered. The densities of nucleic acid and nucleoprotein at 92 per cent relative humidity are between 1.34 and 1.39 (gm./c.c.). If the molecules are considered as immersed in water of density 1 (gm./c.c.), the theoretical densities are 1.26 and 1.33 (gm./c.c.), and the water contents per 100 parts by weight of nucleic acid are 147 and 85, respectively.

The observed values agree better with a three-chain than a two-chain structure; but in the less hydrated nucleic acid structure A (which must be of the same basic form) the corresponding data agree well with a two-chain structure^{11,14}. An obvious explanation is that nucleic acid fibres contain a large fraction of imperfectly crystalline material and, when in the B-form, the non-crystalline material has lower hydration than the crystalline. This hypothesis is supported by measurements of ultra-violet dichroism, which give values much lower than would be expected if the fibres consisted largely of the proposed structures.

X-Ray Diffraction Observations

The B-structure of nucleic acid often crystallizes with a hexagonal lattice which can swell and shrink in directions at right-angles to the c-axis ($a = 46$ A., $c = 34.6$ A. at 92 per cent relative humidity, and $a = 39$ A., $c = 34.6$ A. at 75 per cent relative humidity); the lattice is never very perfect, but as many as sixteen reflexions have been indexed (Fig. 4a). Some specimens show continuous streaks along the layer lines superimposed on the crystalline reflexions, thus indicating that some of the repeat units are arranged at random in the c-direction; that is, some of the material is paracrystalline. One specimen (Fig. 4b) gave continuous streaks and no lattice reflexions on the first and third layer lines,

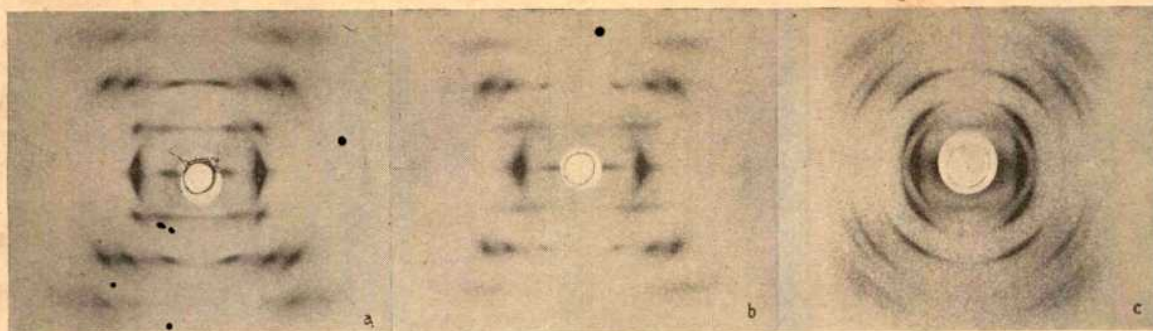


Fig. 4. Central regions of X-ray fibre diagrams of:

- (a) Deoxyribose nucleic acid at 92 per cent relative humidity, showing spots on all layer lines. Crystalline *B* structure. (Nucleic acid from Dr. N. S. Simmons.)
 (b) Deoxyribose nucleic acid at 92 per cent relative humidity, showing spots on even layer lines only.
 (c) Nucleoprotamine (*Sepia* sperm heads) at 98 per cent relative humidity.

and lattice reflexions and no streak on the second and zero layer lines. This means that repeat units are arranged with relative displacement in the *c*-direction of $\frac{1}{2}c$ up and down at random. The layer-line streaks are especially useful in providing the whole structure factor along a layer line. Several possible reflexions are noticeable by their absence in the *B*-crystalline X-ray picture, and this may be accounted for by considering the crystal as consisting of nucleic acid molecules packed hexagonally, in projection on a plane perpendicular to the fibre axis, but with adjacent molecules displaced up and down one-sixth and one-third of the helix period relative to one another. If this arrangement is regular, the hexagonal crystalline structure results, the repeat unit involving three nucleic acid molecules; and if irregular, the various paracrystalline structures are produced.

The lattice of the nucleoprotamine (sperm heads from a variety of species and extracted material) is always hexagonal ($a = 28.7$ A., $c = 34.4$ A. at 98 per cent relative humidity) and fifteen reflexions have been indexed (Fig. 4c). The repeat unit involves one deoxyribose nucleic acid molecule, and packing of the molecules suggests that the molecule as a whole resembles a single-fold helix, probably as a result of the single polypeptide helix existing on the outside of the two-fold nucleic acid helix. The X-ray photographs were measured using a recording densitometer²¹, and the structure factor deduced.

Calculation of the Fourier Transforms of the Molecular Models

The Fourier transforms were calculated using tables of Bessel functions^{4,22} and by drawing phase-amplitude diagrams. The calculations were checked by densitometer measurement on a photograph obtained on a Lipson optical diffraction apparatus using a mask with holes produced by photographic etching²³. The weighting of the atoms, in terms of amplitude of X-rays scattered, was found as follows. That part of the diffraction which takes the form of a system of Bessel functions radiating from the centre of the pattern is produced by the gross helical form of the molecule immersed in water, irrespective of atomic detail; hence the electron density of water (of unit density) was subtracted from the average electron density of each atom. The outer part of the diffraction pattern, consisting of a system of Bessel functions radiating from origins displaced from the

centre of the pattern^{4,22}, arises from periodicities in the electron density inside the polynucleotide helix. As water does not penetrate between the atoms in each helix, no subtraction of electron density of water was made, and relative weighting of the scattering from atoms was different from that above.

Possible Chemical Activity and Biological Functioning of the Molecule

X-ray diffraction shows that deoxyribose nucleic acid *in vivo* has the same molecular configuration when bound to protamine (or possibly histone) in sperm heads, or when in *T*₂ and *T*₄ bacteriophage. It remains to be shown, however, that this structure also exists in interphase cell nuclei or in functioning and duplicating chromosomes.

In any event, it may be useful to consider some characteristics of the proposed nucleic acid structure which may have a bearing on its chemical and biological activity. First, the regular spacing of phosphate groups is necessary for effective combination with basic polypeptides; if the molecule is much distorted, such efficient combination cannot take place. Second, the nitrogen bases and sugar rings present a large external surface on the molecule so that, if other molecules lie on this surface, important Van der Waals attraction may take place. For example, basic dyes do not combine with mononucleotides²⁴ but are bound to nucleic acid. Probably these dyes are bound, not only by ionic linkage to the phosphate groups, but also lie with their planes in close contact with the base-sugar surface of the nucleic acid molecule. Such effects may also be important in protein-nucleic acid interaction. Third, it appears quite feasible for short side-chains to the main polynucleotide chain to occur as branches at triply-esterified phosphate groups and to lie in the grooves of the helix without interfering much with the packing of the deoxyribose nucleic acid molecules. Such side chains could terminate in secondary phosphoryl groups²⁵. Fourth, the free amino-groups of guanine^{6,26} occur at the bottom of a shallow groove about 8 A. wide and about 6 A. deep and are readily accessible to approaching molecules. The biological specificity of nucleic acid may well depend on the presence of these amino-groups²⁷ and the secondary phosphoryl groups at the ends of branches.

We wish to thank Prof. J. T. Randall, Dr. C. P. Rhoads and Dr. C. C. Stock for encouragement and facilities, Prof. K. Felix and Dr. H. Fischer for

assisting us greatly by supplying sperm heads and nucleoprotein specimens, and Dr. Geoffrey L. Brown and Dr. P. M. Cowan for helpful discussion. One of us (H. R. W.) wishes to acknowledge the award of a University of Wales Fellowship, and another (W. E. S.) the award of a research grant from the British Empire Cancer Campaign. The work has been aided by a grant from the Rockefeller Foundation.

- ¹ Avery, O. T., McLeod, C. M., and McCarty, M., *J. Exp. Med.*, **79**, 137 (1944).
- ² Hershey, A. D., Cold Spring Harbor Symp. Quant. Biol., **18**, 135 (1953).
- ³ Vendrely, C., *Bull. Biologique*, **86** (1952).
- ⁴ Wilkins, M. H. F., Stokes, A. R., and Wilson, H. R., *Nature*, **171**, 737 (1953).
- ⁵ Franklin, R. E., and Gosling, R. G., *Nature*, **171**, 737 (1953).
- ⁶ Watson, J. D., and Crick, F. H. C., *Nature*, **171**, 737 (1953).
- ⁷ Crick, F. H. C., and Watson, J. D., *Proc. Roy. Soc., A*, **223**, 80 (1954).
- ⁸ Watson, J. D., and Crick, F. H. C., *Nature*, **171**, 964 (1953).
- ⁹ Wilkins, M. H. F., and Randall, J. T., *Biochim. Biophys. Acta*, **10**, 192 (1953).

- ¹⁰ Arndt, U. V., and Riley, D. P., *Nature*, **172**, 294 (1953).
- ¹¹ Wilkins, M. H. F., Seeds, W. E., Stokes, A. R., and Wilson, H. R., *Nature*, **172**, 759 (1953).
- ¹² Franklin, R. E., and Gosling, R. G., *Acta Cryst.*, **8**, 673 (1953).
- ¹³ Gulland, J. M., and Jordan, D. O., Symp. Soc. Exp. Biol., *I. Nucleic Acid*, 56 (Camb. Univ. Press, 1946).
- ¹⁴ Franklin, R. E., and Gosling, R. G., *Nature*, **172**, 156 (1953).
- ¹⁵ Miescher, F., "Die Histochemischen und Physiologischen Arbeiten", **11** (Leipzig, 1897).
- ¹⁶ Alexander, P., *Biochim. Biophys. Acta*, **10**, 595 (1953).
- ¹⁷ Felix, K., "The Chemical Structure of Proteins" (J. and A. Churchill, 1953).
- ¹⁸ Hammarsten, E., *Biochem. Z.*, **144**, 333 (1924).
- ¹⁹ Astbury, W. T., Symp. Soc. Exp. Biol., *I. Nucleic Acid* (Camb. Univ. Press, 1946).
- ²⁰ Monier, R., and Jutisz, M., *Biochim. Biophys. Acta*, **15**, 62 (1954).
- ²¹ Walker, P. M. B. (in preparation).
- ²² Cochran, W., Crick, F. H. C., and Vand, V., *Acta Cryst.*, **4**, 81 (1951).
- ²³ Hooper, C. W., Seeds, W. E., and Stokes, A. R., *Nature*, **175**, 679 (1955).
- ²⁴ Cavalleri, L. F., Angelos, A., and Bolis, M. E., *J. Amer. Chem. Soc.*, **73**, 4902 (1951).
- ²⁵ Lee, W. A., and Peacocke, A. R., *J. Chem. Soc.*, 3361 (1951).
- ²⁶ Jordan, D. O., Farad. Soc. Informal Discussion, October 1953.
- ²⁷ Brown, Geoffrey L., and Watson, M., *Nature*, **172**, 339 (1953).

NEWS and VIEWS

Royal Society: New Foreign Members

THE election of Dr. G. W. Corner, Prof. W. Heisenberg, Prof. Lise Meitner and Prof. Otto Renner to foreign membership of the Royal Society was announced in *Nature* of May 7. The following notes survey very briefly the main fields of their scientific activities.

Dr. G. W. Corner

DR. G. W. CORNER is the director of the Department of Embryology of the Carnegie Institute of Washington. Over a period of forty years his name has been pre-eminent in studies of the anatomy and physiology of mammalian and, in particular, of primate reproduction. His first research was concerned with the structure and function of the corpus luteum of the sow. His next big piece of work, published in 1923, was a report of the experimental analysis of the menstrual cycle of the rhesus monkey. This was the first study of its kind, and it revealed, among other outstanding facts, that the endometrium may break down without ovulation having occurred. A few years later, Corner was responsible, with Willard Allen, for the isolation of the hormone now known as progesterone, and so began a major development in the whole field of endocrinology. More recently, his studies have been concerned with the analysis of the hormonal basis of the uterine cycle in Primates; with the further description of different varieties of corpus luteum; and with studies of early embryos. Dr. Corner is also a well-known student of medical history, and in a series of books has demonstrated that the physiology of reproduction can be expounded in a way which appeals to, and is understandable by, an audience much wider than laboratory scientists. Dr. Corner is vice-president of the U.S. National Academy of Sciences and also of the American Philosophical Society. Before taking up his present appointment in Baltimore he was head of the Department of Anatomy in the Medical School of the University of Rochester. He held the Thomas Vicary Lectureship of the Royal College of Surgeons of London in 1936; and was George Eastman visiting professor in the University of Oxford during 1952-53.

Prof. W. Heisenberg

PROF. W. HEISENBERG is perhaps best known for his outstanding work in the development of quantum mechanics. In co-operation with Born and Jordan, he developed the first matrix form of the theory, which was later shown to be equivalent to the wave mechanics of Schrödinger. Then he was prominent in pointing out the restrictions on the simultaneous measurement of position and momentum which quantum mechanics implies, and the well-known 'Uncertainty Principle' is named after him. Another outstanding achievement of this period was his theory of ferromagnetism, which was the first to show how the molecular field which Weiss had introduced to account for this phenomenon could be explained in terms of the concept which we now call the exchange force. Prof. Heisenberg in addition has been a leader in the development of nuclear physics in Germany, and during the War took part in the German atomic energy project. Since the War he has been responsible for much of the re-organization of German science and for the plans for the development of nuclear energy there. In addition, he has continued his fundamental scientific research in many subjects, including cosmic rays, turbulence and superconductivity.

Prof. Lise Meitner

PROF. LISE MEITNER is one of the pioneers in the study of radioactivity. Born in Austria in 1878, she took a doctorate at the University of Vienna when women students were considered freaks and subject to all kinds of unpleasantness. Her first publication on a problem in radioactivity dates from 1906, and the next year she went to Berlin and began her collaboration with the chemist, O. Hahn, which was to continue for more than thirty years. She developed the magnetic deflexion of β -rays into an accurate method revealing the presence of sharp energy groups; from such measurements she proved that γ -rays are emitted not before but after radioactive transformation. Among radioactive substances discovered together with Hahn, the mother substance of actinium deserves special mention; they called it protactinium

(not protoactinium as it is often misspelt nowadays). The study of radioactive recoils, of neutron-induced reactions in cloud chambers and of the absorption of γ -rays are a few more topics out of many. Professor in the University of Berlin since 1926 and joint director—with Hahn—of the Kaiser Wilhelm Institut für Chemie in Berlin since 1931, she left Germany in 1938 and has since lived and continued her research in Sweden. Her work with Hahn on the effects of neutrons on uranium came to fruition shortly after she left, in the discovery by Hahn and Strassmann of the formation of much lighter elements such as barium; but it was she (in a paper with O. R. Frisch) who explained the process in terms of Bohr's drop model of the nucleus as nuclear fission.

Prof. Otto Renner

PROF. OTTO RENNER has been professor of botany first at Jena and, since the War, at Munich. Renner's early work was directed chiefly to plant physiology. Between 1910 and 1915 he was interested especially in the problem of the ascent of sap and contributed a number of observations and theoretical considerations in support of Dixon's cohesion theory. For example, he developed the ingenious method of using fern sporangia for determining the cohesive strength of water. From 1912, however, he turned more and more towards genetic studies on *Oenothera*, for which he is chiefly known. Thirty years ago the importance of Renner's work on *Oenothera* would have seemed to lie in his breeding experiments, which resolved de Vries's mutation theory in terms of orthodox genetics. In the perspective of to-day his work has become much more significant than this. For it now appears that the complex differences in *Oenothera* are something between the gene differences as understood in ordinary Mendelian experiments and the differences existing between natural species. Renner put these differences into relation with the chromosomes on which they were based and also with the cytoplasmic elements with which they interacted. He also put them into relation with their developmental expression in the pollen and in the embryo sac, thus illuminating the general problem of fertility. Finally, others working on Renner's foundations have put them in relation to evolutionary processes. In short, no account of the genetics of higher organisms, whether physiological, cytological or evolutionary, would be satisfactory or convincing to-day which did not pay attention to Renner's work.

Johann Georg Gmelin (1709-55)

THE Gmelin family of Tübingen in Germany included several distinguished medical practitioners and scientific workers during the seventeenth and eighteenth centuries. Leopold is remembered for his discovery of potassium ferrocyanide in 1822 and for his "Handbuch der Chemie" (1817-19). His father's cousin, Christian Gottlieb, invented a process for the artificial manufacture of ultramarine in 1828 and was the first to observe the red coloration given to a flame by lithium salts. Johann Georg Gmelin, who died two hundred years ago on May 20, 1755, made his name as a botanist, chemist, pharmacologist and explorer. Son of the apothecary and chemist, Johann Georg Gmelin, he was born in Tübingen on June 12, 1709, and at the early age of fourteen began to study medicine in the local University. In 1725 he publicly defended a dissertation "De glandularum mesentericarum in chylum actione retardativa", and graduated M.D. in 1727. Following in the foot-

steps of two of his teachers, Johann Duvernoy and Georg Bernhard von Bulfinger, he went to St. Petersburg that same year and obtained a scholarship at the Imperial Academy of Sciences, which had recently been founded by Peter the Great at the instigation of Laurentius Blumentrost the younger, who served as its first president during 1725-33. Gmelin was appointed professor of chemistry and natural history in 1731 and two years later, at the request of the Empress Anna Ivanovna, undertook to explore Siberia in the company of the geographer and astronomer, Delisle de la Croyère, and the historian, Gerhard Friedrich Müller. He returned to St. Petersburg in 1743 and later published his monumental works, "Flora Sibirica" (4 vols., 1747) and "Reisen durch Sibirien" (4 vols., 1751). In 1749 he was elected professor of medicine, chemistry and botany at Tübingen, where he died six years later of 'a fever' at the early age of forty-five. The bibliography of his writings in W. M. von Richter's "Geschichte der Medicin in Russland" (3, 219; 1817) includes the dissertations "De rhabarbaro" and "Corticis peruviani in febris intermittibus usum".

The Nature Conservancy: New Members

THE Nature Conservancy announces that the following have been appointed as members: Sir Basil Neven-Spence, Dr. F. Fraser Darling and Sir Wavell Wakefield. The vacancies have arisen through the death of Sir Edward Keeling and the retirement (on completion of their terms of service) of Sir Norman Kinnear and of Prof. J. R. Matthews, who remains a member of the Scottish Committee and the Scientific Policy Committee, but is succeeded by Sir Basil Neven-Spence as chairman of the Scottish Committee. Dr. C. B. Williams and Major D. C. Bowser have been appointed members of the Conservancy's Scottish Committee in succession to Prof. A. D. Peacock and Dr. D. N. McArthur, who have retired on completion of their terms of service. Mr. C. M. Floyd has been appointed a member of the Committee for England. Dr. V. M. Conway has been appointed director of the Conservancy's Merlewood Research Station at Grange-over-Sands in succession to Dr. K. R. S. Morris, who has resigned.

Royal Aeronautical Society: Awards

THE following awards have been made by the Royal Aeronautical Society: *The Society's Gold Medal*: Lord Hives, for his outstanding work in the field of propulsion of aircraft; *The Society's Silver Medals*: Dr. R. A. Frazer, for his outstanding work in aerodynamics over a period of many years, and Dr. A. A. Griffith, for his outstanding research contributions on aircraft engine design; *The Society's Bronze Medal*: Prof. M. J. Lighthill, for his contributions to aeronautical knowledge; *Wakefield Gold Medal*: Mr. J. Taylor, for the design and development of the counting accelerometer; *The British Gold Medal*: Mr. G. H. Dowty, for his outstanding practical achievement in the design and development of aircraft accessory systems; *The British Silver Medal*: Dr. S. G. Hooker, for his practical achievement in the design and development of aero engines; *George Taylor (of Australia) Gold Medal*: Mr. R. C. Morgan, for his paper on "Practical Experience of Airline Engineering"; *Sims Gold Medal*: Dr. D. Williams, for his paper on "Recent Developments in the Structural Approach to Aeroelastic Problems".

Medical Effects of Nuclear Radiation

THE Medical Research Council has set up the following committee to prepare a report on the medical aspects of nuclear radiation: Sir Harold Himsworth (*chairman*), secretary of the Medical Research Council; Sir Ernest Rock Carling, consultant adviser, Ministries of Health and Home Office (Civil Defence), and member of the health policy committee of the Atomic Energy Authority; Sir John Cockcroft, director, Atomic Energy Research Establishment; Prof. A. Haddow, director, Chester Beatty Research Institute; Dr. J. F. Loutit, director, Medical Research Council Radiobiological Research Unit; Prof. K. Mather, professor of genetics, University of Birmingham; Prof. W. V. Mayneord, professor of physics applied to medicine, University of London; Prof. P. B. Medawar, professor of zoology and comparative anatomy, University College, London; Prof. J. S. Mitchell, professor of radiotherapeutics, University of Cambridge; Prof. L. S. Penrose, Galton professor of eugenics, University College, London; Sir Edward Salisbury, director, Royal Botanic Gardens; Dr. F. G. Spear, deputy director, Strangeways Research Laboratory, Cambridge; Prof. J. R. Squire, professor of experimental pathology, University of Birmingham; Prof. C. H. Waddington, professor of animal genetics, University of Edinburgh; Sir Lionel Whitby, regius professor of physics, University of Cambridge; Prof. B. W. Windeyer, professor of radiology (therapeutic), University of London.

Anglo-French Atomic Agreement

THE United Kingdom Atomic Energy Authority and the French Atomic Energy Commission have recently concluded an agreement for the exchange of unclassified information between the two organizations on a range of subjects. The United Kingdom Atomic Energy Authority will furthermore help the French Atomic Energy Commission by giving advice and by supplying experimental quantities of various materials. The purpose of the agreement is to promote and develop the peaceful uses of atomic energy in the two countries in conformity with the movement for international co-operation in the field of atomic energy on a world-wide scale.

Extraction-Rates of Flour

IN a written reply to a question in the House of Commons, the Minister of Agriculture, Fisheries and Food stated that, in conjunction with the Secretary of State for Scotland and the Minister of Health, he is arranging for an independent authoritative review of the scientific and medical evidence now available of the differences in the composition and nutritional value of flour of varying extraction-rates. Lord Adrian, president of the Royal Society, has nominated the following panel to conduct such a review: Sir Henry Cohen, professor of medicine, Liverpool (*chairman*); Prof. L. J. Witts, professor of clinical medicine, Oxford; Prof. J. H. Gaddum, professor of materia medica, Edinburgh; Prof. A. C. Chibnall, formerly professor of biochemistry, Cambridge; Prof. R. A. Morton, professor of biochemistry, Liverpool.

Chemical Engineering in Britain

IN his presidential address, entitled "Chemical Engineering—the Way Ahead" at the thirty-third annual meeting of the Institution of Chemical Engineers on April 26, Sir Harold Hartley directed

attention to the great progress made by chemical engineering since his last address three years ago. Chemical engineering is now generally recognized as a separate branch of technology of the highest importance to industry, and new departments and laboratories have been created in many universities for training students and for research. The Institution has played an important part in these developments, and its activities will be greatly helped by the new headquarters it has acquired through the generosity of its industrial friends.

Chemical engineering is already so wide a subject that it is quite impossible for any one man to master all its ramifications; in spite of this, the tendency is for still wider development, and several growing branches of technology are in need of ever-increasing numbers of specially trained chemical engineers. Sir Harold dealt particularly with three of these branches: the first is 'extractive metallurgy', which is tending to supplant many of the older mechanical processes, of ore concentration by chemical treatment, especially in the case of new or comparatively rare metals, and low-grade ores. The second is the so-called 'biochemical engineering', which calls for a special fundamental training in biochemistry, in order to be able to design plant for the extremely complicated processes involved in the production of antibiotics and similar bodies. The third is 'instrumentation and automatic control': many plants of the future will have to be designed for automatic control, which is by no means the same thing as the addition of automatic control to existing plants. At present there is an almost complete lack of information on plant and process characteristics, and a great shortage of chemical engineers with sufficient understanding of the theory of automatic control, so that progress is very difficult. An essential requirement for this progress, which Sir Harold barely mentioned, is to find some means of diverting a proportion of first-class chemical engineers, whether students or those with greater experience, from industry into the teaching profession, which, at present, is pitifully small in numbers. Unless this can be done, and at a very early date, chemical engineering is in danger of resembling a magnificently designed plant which cannot be worked efficiently through lack of operatives.

Third Pan-African Congress on Prehistory, Livingstone

THE Third Pan-African Congress on Prehistory will be held in Livingstone, Northern Rhodesia, during July 22–28, during which time the Congress will be in session at the Rhodes–Livingstone Museum. Before the meeting there will be a seven-day excursion to prehistoric sites in Southern Rhodesia, and after July 28 an excursion will be made to sites in Northern Rhodesia and the Katanga Province of the Belgian Congo. In addition to the various sectional meetings, it is proposed to hold special symposia on the following subjects: the Kalahari Sands, their definition, age, distribution and method of formation; the dating of the *Australopithecinae*; marine strandlines, their definition, altimetric and faunal correlation (these being reports by the Commission for the Study of Strandlines, set up by the fourth congress of the International Association on Quaternary Research); the early pebble-tool cultures, their definition, dating and distribution; and the importance and the application of the carbon-14 method of dating to African prehistoric cultures. It is also hoped that

the committee on terminology will hold discussions on the following points: whether a true Levalloisian culture exists in Africa or even in Europe; and the application of the terms 'Early', 'Middle' and 'Late', as against 'Paleo-', 'Moso-' and 'Neo-' in Africa and to which areas these terms should apply. The official languages of the Congress will be English, French and German. Further information can be obtained from the Organizing Secretary of the Congress at the Rhodes-Livingstone Museum, P.O. Box 124, Livingstone, Northern Rhodesia.

Engineering Aspects of Combustion: Joint Conference in Boston, Mass., and London

A JOINT conference on combustion has been arranged by the American Society of Mechanical Engineers and the Institution of Mechanical Engineers and will be held in Boston, Mass., during June 15-17 and in London during October 25-27. The object of the conference will be two-fold: to link theory and practice in the field of combustion by presenting the results of theoretical work to practical engineers in the United States, Great Britain and other countries; and to provide an opportunity for practical engineers in these countries to meet together to discuss the applications of theory in the fields of boilers, furnaces, internal combustion engines and gas turbines. Forty papers have been prepared, eighteen by members of the American Institution, and these will be read at both the Boston and London meetings; they are divided between the following five sections: general; boilers; industrial furnaces; internal-combustion engines; and gas turbines. Seventeen other institutions and societies in Great Britain are supporting the Institution of Mechanical Engineers, and the various sessions and facilities to purchase the relevant literature are open to members of all these organizations. Further information can be obtained from the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.

Announcements

THE Otto Schott Commemoration Medal of the Deutsche Glas-technische Gesellschaft has been awarded to Prof. W. E. S. Turner, honorary president of the International Commission on Glass. The Medal is a rare distinction, having been awarded only three times during the past twenty-five years, and Prof. Turner is the first non-German recipient.

THE Challenger Society is prepared to consider applications for small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year June 1955-June 1956. Applications, accompanied by details of the proposed research, should reach the honorary secretary, Mr. N. B. Marshall, British Museum (Natural History), Cromwell Road, London, S.W.7, before June 13.

THE Underwater Explorers Club (2 Thames House, Queen Street Place, London, E.C.4) is sending an expedition to Cyprus to explore the sunken portion of the city of Salamis and to make underwater scientific investigations in the waters around the island and the eastern Mediterranean generally. The main party of eight members will remain in Cyprus until late autumn and will be supplemented by others from the Club for short periods throughout the summer.

A symposium on electromagnetic wave theory will be held at the University of Michigan during June

20-25, under the auspices of the International Scientific Radio Union. The papers will deal with the following topics: boundary-value problems of diffraction and scattering theory; forward and multiple scattering; antenna theory; and propagation in doubly refracting media in wave-guides. Further information can be obtained from the chairman of the symposium, Mr. K. M. Siegel, Willow Run Research Center of the Engineering Research Institute, Ypsilanti, Michigan.

THE second of the international powder metallurgy congresses sponsored by Dr. Paul Schwarzkopf, president of the American Electro Metal Corporation, Yonkers, N.Y., will be held at Reutte, in the Austrian Tyrol, during June 20-23, when the topic of high-temperature and corrosion-resistant materials by powder metallurgy will be discussed. Reutte has again been chosen because of the very large powder-metallurgy works there, the Metallwerk Plansee. About three hundred people from seventeen nations will be attending, including more than thirty scientific workers from Great Britain. Further information can be obtained from George Cohen, Ltd., 600 Group Publicity Department, Cunard Works, Chase Road, London, N.W.10.

THREE special summer courses will be held this year in the Massachusetts Institute of Technology as follows: June 20-July 1, switching circuits (under Prof. S. H. Caldwell and Dr. D. A. Huffman, of the Department of Electrical Engineering); June 20-July 8, current scientific developments concerned with foods and the food industries (jointly run by a number of members of the Department of Food Technology and others); and August 8-19, low-temperature engineering and research (under Prof. S. O. Collins, of the Department of Mechanical Engineering). Application forms and further information on these courses can be obtained from the Summer Session Office, Room 7-103, M.I.T., Cambridge 39, Mass.

THE Gordon Conference on Proteins and Nucleic Acids, under the auspices of the American Association for the Advancement of Science, will be held this year in New Hampton, N.H., during June 27-July 1. In the past, the programme has dealt largely with the physical-chemical properties or the metabolism of proteins, nucleic acids, and their building blocks; this year the theme will be the chemical and structural aspects of proteins and nucleic acids and will be concerned with the recent advances in the structure of biologically active polypeptides, insulin, ribonuclease, and some of the larger protein molecules. Further information can be obtained from the chairman of the Conference, Dr. Frank W. Putnam, Department of Biochemistry, University, Chicago 37, Ill.

WE regret that the report in *Nature* of April 23, p. 717, on an address by Sir Charles Morris to the University of Leeds, contains a mis-statement. Sir Charles said that work on the extension of the chemistry and physics buildings of the University began some weeks ago. It is expected that the first stage will be completed and ready for occupation by October 1958.

ERRATUM. In the communication "Chemical Effects of X-Rays upon Aqueous Solutions of Cortisone and Deoxycorticosterone" in *Nature*, April 23, p. 721, the abscissa are marked "Dose (10^6 eV./ml.)"; this should read "Dose (10^{11} eV./ml.)", as in the legend.

FUNCTIONS AND EDUCATION OF THE CHEMICAL ENGINEER
IN EUROPE

A CONFERENCE on "The Functions and Education of the Chemical Engineer in Europe" was held during March 21-25 in the Assembly Hall at Church House, Westminster, London. It was organized by the Institution of Chemical Engineers in co-operation with the Department of Scientific and Industrial Research, on behalf of the European Productivity Agency of the Organization for European Economic Co-operation. At least thirteen European countries, Australia, South Africa and the United States were represented among the 350 who registered for the Conference, which owed its origin to a document entitled "Chemical Apparatus in the U.S.A." published in 1952 as a report on Technical Assistance Mission No. 23. This report directed attention to two points in particular: (1) the leading position in the chemical industry which the United States has acquired in recent years is to a great extent due to the rapid development of the profession of chemical engineering; (2) the importance of chemical engineering is generally recognized by the Government and by industry in the United States; but this is less frequently the case in Europe.

The three main objectives which the Conference under Project 297 of the European Productivity Agency was asked to explore were: (1) the necessity for more chemical engineers and more schools of chemical engineering in the universities and technical colleges; (2) the necessity for more financial support for chemical engineering research both in universities and technical colleges, and in specialized laboratories with support from government and industry; (3) the necessity for a more general recognition of the part that chemical engineering is bound to play in modern industry.

The Conference was opened by the Lord President of the Council, Lord Salisbury, and some introductory remarks were made by M. R. Gregoire, who is deputy director of the European Productivity Agency. It was divided into six sessions.

The first session, on "The Part played by the Chemical Engineer in bridging the Gap between Research and Plant Construction", was opened by Sir Christopher Hinton, managing director, Industrial Group, U.K. Atomic Energy Authority. The Authority, he said, has a series of people working on the design of a process plant, from the pure scientist at one end to the detailing mechanical engineering designer at the other, who need have little knowledge of the scientific principles which underlie the process. The chemical engineers fit into this scheme like bands in a spectrum.

The second paper, by Dr. K. Riess, a director of the Farbenfabriken Bayer A.G., Leverkusen, was on "The Process Engineer in the German Consumer Goods Industry". He remarked that the American method of training chemical engineers produces extraordinary versatility and "cannot but have the disadvantages of all compromise solutions because versatility is bought at the price of thoroughness". The third paper, on "The Function of the Chemical Engineer as a Link between Pure Research and its Industrial Applications", was by Dr. L. Morandi, vice-president of the Montecatini Co., of Milan, who pointed out that the chemical engineer effects the first control of an economic nature on the results of

research. The next paper was by Dr. R. Holroyd, director of research, I.C.I., Ltd., on "Considerations of Technical Staff Requirements in the Evolution of an Industrial Chemical Project". Dr. Holroyd emphasized that, in bridging the gap between research and industrial production, overall responsibility must be vested in one department and preferably ultimately in one individual.

The final paper, by Mr. C. F. Kearton, a director of Courtaulds, Ltd., was on "The Chemical Engineer in a Man-made Fibre Industry". He said that the chemical engineers have grown into an accepted and valued group within his Company. He illustrated their work by reference to developments of a new chemical fibre, the improvement of a retort design in the manufacture of carbon disulphide and the erection and operation of the Company's new Alabama factory, which has exceeded its designed output.

The second session, on "The Chemical Engineer in Plant Operation and Management", was under the chairmanship of Dr. K. Riess, who is also chairman of the Verein Deutsche Ingenieure, Fachgruppe Verfahrenstechnik. The first paper was by Mr. J. A. Oriel, of the Shell Petroleum Co., president designate of the Institution of Chemical Engineers. He spoke from personal experience of the thrill of first operating a new petroleum plant and getting it on stream. The second paper, by M. N. Chorine, directeur des développements et recherches à la Société des Produits Chimiques Coignet, Belgium, was on "The Role of the Chemical Engineer in the Operation and Management of Chemical Plants". Development in Belgium, he said, has been rather slow; this he attributed to a lack of the technological spirit in chemistry. The next paper, by Dr. K. Winnacker, chairman of Farbwerke Hoechst A/G of Frankfurt said that the experience of German industry was that it is better to divide responsibility, the chemist being responsible for quality and production and being assisted by the engineer, who draws up the plans for a new process and is responsible for its construction. The final paper, by M. E. Bognar, chef de la section de Génie Chimique de la Compagnie d. Saint-Gobain, France, pointed out that the chemical engineer is the person best situated to co-ordinate the ideas of the research worker and the economist.

Dr. Vlugter, of the Amsterdam Laboratory of the Shell Company, presided over the third session, which was devoted to courses of study for a primary degree in chemical engineering. The first paper, by Prof. K. Schoenemann, of the Institut für Chemisch Technologie der Technischen Hochschule, Darmstadt, Germany, discussed how far the traditional training of the chemist can be brought into line with recent developments. In Germany, in addition to the training of engineers in unit operations, the training of chemical technologists must be promoted.

The second paper was by Prof. T. R. C. Fox, She professor of chemical engineering, University of Cambridge. He considered the best way of fitting the training of chemical engineers, and indeed technological courses, into the general background of university. Prof. E. Kirschbaum, of the Institut für Apparatebau und Verfahrenstechnik of the Technische Hochschule, Karlsruhe, gave details of the first full course for chemical engineers, held at h

College, which was inaugurated in 1928. Prof. J. Danze's paper on the training of chemical engineers also gave similar details for the chemical engineering course at the University of Liège. Prof. H. Kramers and Dr. P. M. Heertjes gave some notes on chemical engineering courses in the University of Delft.

Prof. K. G. K. Peters, of the Technical University of Vienna, said that chemical engineering should be based on profound chemical reasoning. He considered that its teachers should be well versed in both chemistry and mechanical engineering, which represent quite different worlds of ideas. The final paper of the session, by M. J. Givaudon, Ingénieur Conseil à l'Union des Industries Chimiques de France, stressed the importance of numerical calculations in undergraduate training.

Session IV dealt with other education schemes such as those for postgraduate and part-time students; Prof. F. H. Garner, of the University of Birmingham, presided. Mr. C. J. Borelus, of the Svenska Skifferolje Aktibolaget, described the development of chemical engineering in the Kungl. Tekniska Högskola in Stockholm and the Chalmers Tekniska Högskola in Göteborg; unfortunately, both professorships are vacant through lack of suitable applicants.

Prof. M. B. Donald, Ramsay Memorial professor of chemical engineering, University College, London, and Prof. J. M. Coulson, professor of chemical engineering at King's College, Newcastle upon Tyne, jointly introduced a paper on the postgraduate course for providing training in chemical engineering for those who already have a degree in chemistry, physics or mechanical engineering. Such courses have been available for some thirty-three years in Britain, and form the basis for the development of the undergraduate course.

Prof. S. G. Terjesen, of the Norges Tekniske Høgskole, Trondheim, the editor of the previous O.E.E.C. report (No. 23), spoke of the methods and theory of process control in chemical plants, and the knowledge that a chemical engineer should have of these subjects to enable him to deal with the ever-increasing instrumentation of chemical processes.

Mr. R. W. Blount, staff inspector of the Ministry of Education, spoke of the part-time course in chemical engineering leading in Britain to a Higher National Certificate. He pointed out that these schemes are unique in so far as they are fostered only in Britain. These examinations and courses provide a very convenient method for taking the examinations of the Institution of Chemical Engineers. The establishment of some 'sandwich' schemes, in which the student spends periods alternately at a college and in works, instead of one day or so a week over a long period, would probably help in recruitment for these courses.

The final paper, by Dr. G. U. Hopton, of the North Thames Gas Board and chairman of the Board of Examiners of the Institution of Chemical Engineers, was on the associate membership examination of the Institution. He showed that it places no undue limitation on those who are eligible for entry, and that it has recently been reorganized to ensure that applicants are more adequately fitted as members as the science of chemical engineering progresses. He finally directed attention to the design problem feature of the examination, where the student is expected to design a chemical plant from first principles and where he encounters most of the types of problems which he would be likely to meet later in his career.

The practical training or apprenticeship of the chemical engineer after graduation was considered in the fifth session, under the chairmanship of Prof. M. Letort, directeur de l'École Nationale Supérieure des Ind. Chim., Nancy.

Mr. F. H. Pugh, of De Bataafsche Petroleum Maatschappij, gave details of a scheme which has been worked out for training in refinery operation. Previously, with a haphazard scheme, the results had been uneven; but, now that it has been set on an organized footing, both the firm and the apprentices have gained considerably. This paper was followed by another one from representatives of a firm which manufactures plant, by J. P. V. Woollam and J. M. Solbetti, of Simon Carves, Ltd.

Mr. D. Morten, of the Shell Refining and Marketing Co., Ltd., described the use of sponsored courses for training students before entry into industry. For the past three years, these courses have been conducted during the university long vacation. The students are accompanied by a tutor (one of their senior lecturers), and the refineries are now certain that the students gain extra value from this course. The presence of the tutor lightens the load on the refinery staff, who are then free to give specialist lectures on industrial management problems.

Mr. J. Newby, the secretary of the International Association for the Exchange of Students for Technical Experience, then told of the remarkable growth of this organization for broadening the knowledge and culture of technical students. Since it was founded in 1948 with ten member countries and 920 students, it has grown to nineteen member countries and 4,267 students in 1954. In the years 1950-54, the chemical engineering students taking advantage of travelling abroad under this scheme amounted to 1,285 out of a total of 18,000.

The chairman of the final session was Sir Harold Hartley, president of the Institution of Chemical Engineers, and the topic discussed was research.

Prof. J. Cathala, director of the Institute of Chemical Engineering, University of Toulouse, produced an interesting classification of possible research subjects and made the following remark: "The Greiner report published in 1951 is a most remarkable work, which once again bears witness to the efficiency of our British colleagues when they form a committee for study purposes". Dr. H. Miesner, of the Farbenfabriken Bayer AG, Leverkusen, described the organization of the VDI-Fachgruppe Verfahrenstechnik into thirteen groups for the study and development of research problems. Mr. A. S. White, head of the Chemical Engineering Department of the Atomic Energy Research Establishment, Harwell, said that one of the lessons to be learnt from the development of nuclear engineering is that a considerable quantity of essential information is lacking for design purposes; this provides a powerful incentive for more basic research to be undertaken on the subject. Prof. S. Kriesakalt, director of the Research Institute for Process Technology of the Rhine-Westphalian Technische Hochschule at Aachen, described the work done in his new research station (which is of the type envisaged by the Greiner report and which has, unfortunately, not yet been implemented in Britain).

Prof. P. M. Heertjes, of the Nijverheids Organisatie TNO of The Hague, advocated that financial policy for research should be on a long-term basis to provide the research worker with greater freedom.

The final paper was by Prof. D. M. Newitt, Courtauld professor of chemical engineering in the Imperial College of Science and Technology, London, who discussed the scope and nature of the research which can appropriately be undertaken in a teaching department of chemical engineering.

The final summing-up of the results of the Conference was made by Sir Harold Hartley, who said: "What has become abundantly clear to me as the days progressed is that, with one partial exception, there is a general agreement among the European countries represented here as to the conception of chemical engineering as a fourth primary technology which now takes its place alongside the other professions of civil, mechanical and electrical engineering. And I know that that view is shared by all the countries of the British Commonwealth. That is the first major result of our Conference and it is one of great importance. We did not know until now the degree of unanimity that existed between us. The second result is to show that there is a large unsatisfied demand for chemical engineers, and consequently a need to expand and multiply the schools of engineering in each country... we have already examined the need for more research and the lines on which it should proceed and the advantage of closer co-operation between us. So we have answered two questions put to us in the affirmative. For the third we must rely on the Press, and I hope that our nomenclature has not been too technical to obscure the main issues".

Coming to the partial exception, he said: "Let me begin by expressing our admiration and our indebtedness to Germany for what she has contributed in the field which we like to call chemical engineering. Let me remind you of what the world owes to Adolf Baeyer and Emil Fischer and their pupils and to the Haber process, of those great pioneer developments of the synthetic industry in Germany around about 1900. I shall never forget the impression made on me by the imaginative chemical engineering of the Haber plant at Ludwigshafen when I first saw it. Now our German friends, for good reasons from their experience, have chosen rather a different approach to us. Let me say at once that we admire the skill of their *Verfahrens Ingenieure*, which is seen to such advantage in the mechanical design of their plants. We could do with more of that same breed in other countries, particularly in the field of plant manufacture. Their *Verfahrens Ingenieure* represent one band in Sir Christopher Hinton's spectrum, or one arm of Prof. Donald's distribution curve. I must say that I was greatly comforted by what Prof. Schoenemann said of the need to supplement the classical chemist by the chemical technologist, and how unfortunate it would be if the need for process engineers were to hinder the technological education of a number of chemists. Thereby he is building a bridge between our different approaches. Chemical engineering is still a very young profession; it is dynamic and it is in the stage of rapid evolution. So it is no wonder that there are different patterns, and it is all to the good that it should develop on independent lines in different countries and universities. It is its adaptability and its flexibility that are its great strength. As Mr. White said, its ubiquity is its most marked characteristic. Its techniques are invading almost every industry and the hope of satisfying the world's growing demands depends more and more on chemical engineering, call it by what name you will".

INSTITUTE OF PHYSICS EDUCATION GROUP CONFERENCE

AT the annual conference of the Education Group of the Institute of Physics, held on April 14 and 15, with Dr. J. Topping as chairman, the teaching and applications of thermodynamics, and the place of physics in a liberal education were the subjects of the main contributions.

Prof. E. A. Guggenheim (University of Reading), speaking on "Fundamentals of Thermodynamics", said that the first concept for the beginner should be free energy, and the subject should be developed from the Gibbs-Helmholtz equation, which would be presented as an axiom in a purely classical treatment, or as a consequence of the distribution law in terms of statistical mechanics. Entropy, and the distinction between reversible and irreversible changes, should not be introduced too early. The student should proceed in stages from simple isothermal reversible cases, working always in terms of decrease in free energy rather than of entropy increase.

The achievements and problems of the heat engineer were described by Dr. G. G. Haselden (Imperial College of Science and Technology, London) in a paper on "Thermodynamics in Industry". The development of new materials for high temperatures at which the heat acceptance of an engine can match the heat liberation of the fuel, the search for cycles more efficient than those based on the constant-temperature evaporation of water, and the choice of the best cycle for the gas turbine, are among the applications of thermodynamics to large-scale power generation. Also, by exposing the low efficiency of the turbine system, thermodynamics has stimulated the search for the fuel cell, which has already, so far as gaseous fuel is concerned, reached a promising stage. While the seasonal fluctuation of the heat-pump's output and its high capital cost make it uneconomic as an ordinary means of heating in Britain, it is more attractive in chemical industry, to bridge the small interval between the temperatures at which heat is given out by one process and absorbed by another, as, for example, in a sugar evaporation cycle.

In designing air liquefaction and separation systems, the components are matched to the properties of air (to eliminate discontinuous latent heat jumps) as in the Heylandt process, where the expansion engine operates in the supercritical region, and the interchanger below it. Ideally, heat should be supplied and extracted at every level in an air separation column, and heat pumping is now used for supplying or extracting in several places instead of at the extremes. Following Ruhemann's analysis of the entropy increases at various stages of the Linde system, the aim is to approach reversibility at each stage. As a result, air-separating plants have been made which operate at an efficiency of 23-25 per cent, compared with a theoretical efficiency of 35 per cent and the 12 per cent of the original Linde double column.

Opening a discussion on the teaching of thermodynamics, Prof. M. W. Thring (University of Sheffield) outlined the organization of classes for various groups at the University of Sheffield, and mentioned the importance of the emotional attitude towards the subject, and its various functions. Free energy is a 'good' function, and entropy a 'bad' function the increase of which is to be discouraged—gain of

entropy by a system representing a positive loss of virtue. Clarity is necessary in distinguishing between the 'first-law' efficiency of a system and the thermodynamic efficiency. Dr. N. Kurti (Clarendon Laboratory, Oxford) deplored the conventional distinction between heat and thermodynamics, and suggested that a single course, implanting faith in thermodynamics by the statistical approach, should serve for all university students whatever their specialist interests. Dr. R. S. Silver (John Brown Land Boilers, Ltd., Clydebank) presented the practical engineer's point of view. Thermodynamics, he said, is badly taught because its concepts are of a subtlety beyond the grasp of the average physicist and the average teacher. Hence, the exposition of the second law is not normally adequate to equip the engineer to face industrial problems. He advocated teaching in terms of ordered and disordered energy rather than work and heat—ordering rather than energy conversion—and abandoning the usual idea of efficiency for a proportioning ratio between ordered and disordered energy expressed in terms of temperatures.

Dr. A. W. Barton (City of London School) opened the second day's proceedings, speaking on "Physics in the School Curriculum". The historical development of the subject is a treatment which marches in line with the development of the individual boy, with the early passion for collecting facts and slowly emerging capacity to relate them to general principles. Physics is, he said, an educational discipline equalled only by Greek. Dr. Barton's lively exposition of his own teaching methods was a memorable feat, which illustrated his general argument convincingly.

Mr. W. Llowarch (Institute of Education, London) spoke on "Non-Specialist Science in the Sixth Form", outlining the scheme he developed during his time at Stowe School. For a year's course, the boys were divided into three groups, each doing one term of biology, physics and chemistry in rotation, the work being taught by specialists. Lectures on isolated subjects of special or topical interest had proved on the whole preferable to a more continuous course, and biology seemed the most generally appreciated of the three. After discussing the aims of the course, Mr. Llowarch gave some examples of topics which had been particularly successful.

"Education through Physics" was the title of the talk by Prof. F. A. Vick (University College of North Staffordshire). One of the aims of education, he said, is to toughen the mind by exercise on problems. The historical approach, while not generally useful, can be valuable in showing the devious routes by which accepted theories arose. Students should be encouraged from the beginning to consult original papers, and in the final year at the university, while continuing a broad education, should reach the frontiers of knowledge in one or two places. In subsidiary physics courses, the future technologist should regard the subject not as a mere tool, but as a contribution to his full education. Prof. Vick regards physics, freed from the mechanistic outlook of the nineteenth century, as a living subject which stands equal to classical and modern studies as the core of a complete education.

Mr. N. R. Hanson (University of Cambridge) then described the undergraduate course in the history and philosophy of science, developed during the past five years in the University of Cambridge. The aim, he said, is not to humanize the scientist by superposing a little culture, but to help him to understand

what he is doing. History leads to a better appreciation of an idea by tracing the steps in its development. Philosophy, as concerned with the meaning of concepts, and why they are fashioned in one way rather than another, may help a man to be a better physicist. Mr. Hanson explained the close collaboration by which the course is dovetailed with the tripos lectures in physics, and spoke of the enthusiasm with which it has been received, and the growth of the Philosophy of Science Club at Cambridge.

G. R. NOAKES

PROPOSED MUSEUM OF SCIENCE AND TECHNOLOGY IN THE NORTH-WEST OF ENGLAND

A MEETING was held on February 18 at the College of Technology, Manchester, to consider a proposal to establish a museum of science and technology in the north-west of England. Interest in such a museum came from a number of quarters—from industry and from academic and educational life. Sympathy and support for this scheme has also been shown by municipal and other bodies. The meeting was attended by representatives of industry, the universities, trade and professional bodies and representatives of museums in Manchester, York, Birmingham and Liverpool.

A resolution was moved by Mr. L. Lever, M.P., and Dr. P. F. R. Venables, and carried unanimously, that a museum of science and technology be established, and an executive committee be appointed in order to investigate the details involved in setting such a project in action, and to report back at a subsequent meeting of the body as then constituted. The executive committee consists of Mr. H. G. Greg (for the Textile Institute), Mr. Niel Pearson, Prof. L. Rosenfeld (Department of Theoretical Physics, University of Manchester), Mr. R. M. Sayce (keeper, Manchester Museum) and Dr. P. F. R. Venables (principal, Royal Technical College, Salford); Mr. P. Lennox-Kerr (editor, *Skinner's Silk and Rayon Record*) and Dr. W. Mays (Department of Philosophy, University of Manchester) are the joint secretaries.

The project for a museum of science and technology arose from the joining together of two streams of interest. In industry, especially the textile and engineering industries, there has for a long time been felt the need for establishing an industrial museum to take account, among other things, of the economic history of the region. At the University of Manchester there was a group of people interested in the establishment of a museum for the history of science and technology. It was felt by them that the history of science should take a more important place in university education, where there is an ever-increasing need for relating the diverse fields of study which make up the university curricula. In the promotion of the study of the history of science, a museum plays an essential part, comparable to that of a laboratory in the experimental sciences.

The intention is to establish a science museum which will show the development of industry in the north-west of England from the early days of the Industrial Revolution to the present day in relation to the scientific background. It is hoped that it will embrace a number of fields of inquiry—from the natural sciences to economic history—and lead to

their integration, and in this way provide a link between industry and the academic world.

Such a museum can act as a repository of documents and objects of great historical value, which otherwise run the risk of disappearing through decay or neglect. It is hoped that when established it will be a centre of research where the impact of the sciences upon each other and upon technology can be studied. Its activities would cover pure science, discovery and invention, and manufacture and use. Future developments and sociological implications would be taken into account. There are already clear indications that the proposed scheme is of public, as well as specialist, interest. As well as covering the history of science it will endeavour to acquaint the general public with the most recent scientific advances and their industrial applications.

At a time when technical knowledge is becoming increasingly important, such a museum can play a vital part in modern education. Early introduction to large areas of scientific knowledge and its application is desirable if we are to prepare young people to enter such fields of study. Bringing young people into such an institution would give them a chance of tracing the evolution of specific representative manufacturing processes from hand processes to modern automatic equipment, and stimulate in them the desire to play a part in the continuation of such developments. It has been suggested that a preliminary exhibition be held to indicate the scope of the museum, and to interest the public in its activities.

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND REPORT FOR 1953-54.

THE fifty-third annual report of the Carnegie Trust for the Universities of Scotland, covering the year ended September 30, 1954*, records increasing preoccupation of the Executive Committee with appeals for assistance from students who have been deprived of their bursaries by the local education authorities through failure to pass the requisite degree examinations at the appropriate times. In all but the most exceptional cases, the Trust's assistance is limited, however, to the class fee, and no maintenance grant can be made. In the year under review, the number of students assisted increased from 1,301 to 1,408, almost entirely in science and medicine, the amount expended increasing from £20,003 to £22,007. While the Executive Committee recognizes that, with the length and expense of the courses in dentistry and medicine, many students, despite substantial bursary awards from education authorities, are severely taxed to make ends meet, it points out that, particularly where an education authority bursary is held, there can be no assumption that additional assistance from the Trust is automatically forthcoming. Every application is considered on its own merits, and clear evidence of need must be shown.

Expenditure on the research scheme increased by about £2,000 to just short of £35,000, and the Executive Committee regards the scheme as continuing to yield satisfactory results. While no upper limit has been fixed for the sum expended on

fellowships, scholarships and grants, in practice the amounts required have not varied significantly from year to year. Certain other limits are at present fixed by annual decision: these include £4,000 to the universities for distribution at their discretion to lecturers and professors engaged in research projects at home and abroad; £500 to the Royal Society of Edinburgh; and £6,000 to the scheme by which not more than ten senior members of the staffs in the universities are afforded an opportunity of three months or more to pursue their research investigations abroad. Uncertainties as to expenditure lie rather in the growing region of guarantees against loss on publication of books of a kind that might have great difficulty in getting acceptance by a publisher.

Besides details of grants made under the ninth quinquennial distribution (October 1, 1952-September 30, 1957), the abstract of accounts, lists of publications by fellows, scholars and recipients of grants received since September 1953, of papers assisted by grant for the session, and of fellowships, scholarships and grants under the research scheme, there is appended the usual report upon the work of investigators under the research scheme during the year. In the mathematical, physical and engineering section, high praise is given to D. M. Colvin's high-pressure ionization chamber investigations and to W. D. Munn's work on problems relating to abstract algebra; K. M. Swanson has made steady progress in his study of nuclear magnetic resonance effects in semi-conductors, and Dr. E. Wolf, as a result of his study of interference and diffraction of light, has proceeded to a research fellowship at the University of Manchester. In medicine, I. A. Macpherson's work on the development of tissue-culture methods in the study of poliomyelitis and Jean D. Garven's work on the estimation of 5-hydroxytryptamine in extracts of animal tissues are specially mentioned.

In the chemistry section, Dr. T. R. R. McDonald's X-ray crystallographic investigation of ammonium bifluoride, which confirmed views assuming a resonance state for the bifluoride ion and afforded no evidence of interaction between the fluorine and the hydrogen atoms of the ammonium ion, is specially commended. Mr. R. Logan's investigation of phosphate metabolism in the rabbit, using radioactive phosphorus as indicator, showed that under *in vitro* conditions the cell nuclei of rabbit liver take up phosphate from the cytoplasm. Similar results were obtained with the spleen and the intestinal mucosa; but no evidence of the reverse passage was obtained in the liver or the spleen, although a small but significant transfer occurred in the intestinal mucosa. Reference is also made to the work of A. N. Hamer, D. Calvert and R. C. Taylor at the University of St. Andrews on the construction and use of apparatus for applying mass-spectrography to the measurement of ionizing potentials and identifying products of pyrolysis of organic compounds. L. R. Newlands has obtained a series of triazole compounds by the action of aromatic aldehydes on a new derivative of mandelic acid obtained from mandelic amidate hydrochloride and phenylhydrazine. C. A. Goodlad's work on the enzymes of rat liver which hydrolyse phosphoric esters of sugars has demonstrated the complex nature of these phosphatases. In the biological section special mention is made of G. D. Scott's work on the ecology and physiology of lichens, which has demonstrated the possibility of growing the fungal constituent of a lichen in pure culture, and of that of J. Weir on the ecology of the

* Carnegie Trust for the Universities of Scotland. Fifty-third Annual Report (for the Year 1953-54). Pp. iv+72. (Edinburgh: T. and A. Constable, Ltd., 1955.)

ant *Myrmica*.² In geology and geography, continued progress is reported in the study of important fossils from the coal measures, in J. Phemister's gravimeter survey of the Highlands of Scotland; and W. C. Jardine's work on the relation between shore-lines and river-valley development, with particular reference to the Southern Uplands of Scotland.

EUROPEAN PRODUCTIVITY AGENCY

A RECENT issue of the Information Bulletin of the European Productivity Agency of the Organization for European Economic Co-operation describes the work of the Agency's Human Factors Division (6-7; December 1954-January 1955).

The Human Factors Division was the last of the five operational divisions of the Agency to be developed, and has not yet reached its final shape and structure. It deals with those human aspects of productivity which are the daily concern of men and women at all levels in industry.

Three sections of the Division were envisaged to cover three aspects of its work: man as an individual; man as a member of a group or a number of groups; and, thirdly, man as a member of a trade union.

The first aspect of the work in the Division impinges on a variety of sciences and technologies, including physiology, psychology and production engineering, and covers the adaptation of machinery and physical conditions of work to the obtaining of optimum results. This field of research is better known and more highly developed in Europe than others with which the Division has to deal, and the Division therefore tends to concentrate on encouraging and supporting the work of local, national and international institutions which have already specialized in this research. Where such institutions do not exist, the Division aims at encouraging their creation.

The second section of the Division's programme deals with the sociological aspects of productivity. It is concerned not only with techniques, but also with educational processes. In sociological problems of work, Europe is, in general, behind America. In this field, the Division will have the task of encouraging original research work and education by organizing visits to America by young men or experts from Europe who have already begun to study these subjects, and by similar visits from one European country to another. Congresses and seminars are being organized and American consultants are being appointed to disseminate in Europe the best results of American learning and practice. For example, the recognition given to the importance of the foreman and his training in technical and social skills has not been widely accepted in Europe or its consequences fully recognized. The tendency to concentrate attention on recently developed industries, particularly the manufacturing industry, has meant that the human problems of utilities and commercial firms have been overlooked. The Division is also interested in such public services as railways, and one of its projects aims at organizing a pilot analysis of human factor problems in the railways of Europe. Study will also be undertaken of office work in banks, insurance companies and commercial firms.

The third section of the work of the Human Factors Division is concerned with trade unions and trade unionism in general. What distinguishes this

so-called section from the others is the method of approach. It tries to bring to the door of trade union organizations in Europe the techniques, ideas and principles which are the basis of productivity in general. If the drive for European productivity is to be effective, it must involve not only the enterprises, the managers, the head men of European industry; it must also reach the workers.

Some of the activities in this section are of a direct educational nature. Others tend to place at the disposal of trade union organizations in various countries all the information which can be found in every field, either in America or in Europe. Lecturers and American consultants who are themselves experienced trade unionists are recruited so that they may share their experiences and discuss them with their European colleagues. European consultants and lecturers, who form a panel arranged within the Division, are ready to organize courses for European trade unionists.

The work of this Division is not in any sense isolated from the work of the other divisions of the Agency. A division with which the Human Factors Division has to work in close unison is the Business Management Division. Another is the Economic Factors Division, which is concerned more specifically with economic problems. Yet another is the Agricultural Division, where human factors are just as important as they are in industry. In short, the Human Factors Division is at the service of the Agency as a whole, for the human element can never be dissociated from productivity.

THE PSYCHOLOGIST AND PERSONNEL MANAGEMENT

DISCUSSING the role of the psychologist in personnel management, Dennis McMahon suggests that the psychologist is useful to the personnel manager because he is trained and experienced in tackling personnel problems in a scientific fashion. 'Scientific' has nothing to do with apparatus and relatively little to do with specialized knowledge; it has to do with approach, with method (*Personnel Management*, 37, No. 331; March 1955).

Sketching the way in which occupational psychology has developed in recent years, McMahon shows that in the 1920's and 1930's the topics engaging the attention of psychologists were work-study, training, selection, lighting and fatigue. Attempts were made to generalize from the results that were achieved, but these broke down; what was applicable in one industrial situation was totally inadequate in another. Human factors often arose which completely nullified the results of carefully planned scientific experiments.

Despite this, some recent researches in the field of employee relations have produced results which stand up as 'general findings' in industrial situations. These are few and fall into the category of 'blinding glimpses of the obvious'. Among them are the following:-

(1) Workers who are kept informed of how they are doing, who have knowledge of results, do better than less intelligently treated workers.

(2) Success follows the supervisor: when supervisors have been moved around, production-rates tend to be moved around with them.

(3) Supervisors who are employee-centred get more out of their workers than do the autocrats, or the more technically minded supervisors.

(4) On the whole, small working groups or teams do better than large ones.

(5) Workers who complain about the canteen and other things are usually complaining about something else but have displaced their resentment on to a handy 'whipping-boy'.

(6) Groups which set their own production targets after free discussion do better than groups which have their goals set for them—even when the setting has been done by enlightened and kindly masters.

STRENGTH OF THE SHELL OF THE HEN'S EGG

By DR. J. BROOKS and H. P. HALE

Low Temperature Station for Research in Biochemistry and Biophysics, University of Cambridge, and Department of Scientific and Industrial Research

LITTLE is known about the strength of an egg except that for eggs of the same species there is no relation between size and strength, and that differences in strength can be only partly explained by differences in the thickness of the shell¹; further work was therefore undertaken. A constantly increasing load was applied at the rate of 100 gm./sec. to an egg lying lengthwise between two parallel plates of polished hard brass with a Vickers hardness number of 185 kgm./sq. mm. The apparatus recorded the increasing load (w) applied to the egg at the two opposed points on its equator, and the diminution in distance (d) between the two plates during loading. The apparatus ceased to record when the shell fractured, thus giving w_c and d_c at the instant of cracking. The extent of deformation (δ) was recorded 120-fold on a chart. The relation between w and d for a single egg was linear or nearly so. For loads short of w_c , the deformation was almost entirely recoverable on removing the load. Unless otherwise stated, all the relations mentioned below were highly significant ($P < 0.001$).

The results with 365 hen eggs ranging in weight from about 45 to 65 gm. are summarized in Table 1 (where t denotes the thickness of the shell in the region where the crack started). Most of the measurements were made on samples of 36 eggs drawn at random from larger batches obtained from different sources at different times of the year. There was little difference between samples, but large differences within samples. For example, sample means for w_c/t ranged from only 10.5 to 11.6 kgm./mm., whereas the range for individual eggs within a sample might be as large as 8–15 kgm./mm.

Correlation coefficients are given in Table 2. The value of the coefficient for w_c with t is as great as, or greater than, that reported by other workers; even so, only about 58 per cent of the variance can be explained by differences in shell thickness. The scatter of the results was so great, in fact, that they could be almost equally well expressed by relating

Table 2

Relation	Coefficient (r)
$w_c : t$	$+ 0.761 \pm 0.022$
$w_c : t^2$	$+ 0.757 \pm 0.022$
$w_c : d/w$	$- 0.714 \pm 0.026$

w_c to t^2 (cf. Table 2). The value of w_c/t tended to increase with increasing shell thickness.

The correlation between w_c and the slope of the $d-w$ curve was unfortunately not pronounced enough for prediction purposes; if it were, w_c could be measured without cracking an egg. Nevertheless, by applying the same load—short of w_c —to a number of points around the equator of the same egg, it was possible from the values of d to show that the differences within a single egg were too small to account for the differences between eggs. There was no relation between w_c and the size of the egg; but its shape had a slight influence, w_c/t tending to increase with increasing symmetry (r equalled $+ 0.33$ when the breadth of the egg divided by its length was taken as a measure of symmetry). No relation was found between strength—as represented by w_c or w_c/t —and the average number of pores in a unit area of the shell.

When the shell was suitably blackened by an extremely thin coating of silver or by staining it with Verhoeff's stain, a rough estimate of the pressures sustained during loading could be obtained by measuring microscopically the total area of the numerous high lights presumably formed by the plastic deformation of the tips of minute asperities on the shell by the harder plates. The results obtained by applying a number of loads to different regions on the shell of the same egg are set out in Table 3.

Table 3

$w_c = 4.75$ kgm.; $t = 0.41$ mm.

Region	Top plate				Bottom plate			
w (kgm.)	2.30	3.17	4.03	4.75	2.30	3.17	4.03	4.75
Area of contact (sq. mm.)	0.21	0.26	0.45	0.58	0.21	0.34	0.54	*
P (tons/sq. in.)	10.9	12.2	8.9	8.2	10.9	9.3	7.5	*

* Egg cracked

An egg can sustain high pressures without cracking, and it is probable that the values in the table are under-estimates. The shell appears to resemble metallic surfaces in that the real area of contact is nearly proportional to the applied load². Only a very small proportion of the observed values of d was derived from the plastic flattening of surface irregularities, the remainder being derived from the elastic deformation of the shell as a whole.

Using large or small values of w_c/t as a criterion of unusual strength or weakness, the strongest ten and the weakest ten eggs were selected from a sample of seventy-two. For each egg the Vickers hardness number of five transverse sections of the shell near the start of the crack was measured with a G.K.N. microhardness tester using a load of 100 gm. Three rows of six impressions were made on each section parallel to the inner edge of the shell, and at distances from it of $\frac{1}{4}t$, $\frac{1}{2}t$ and $\frac{3}{4}t$. A rough estimate of brittleness³ was obtained by measuring microscopically the area of superficial shattering that sometimes adjoined the pyramidal impressions. The remainder of the shell and its adhering membranes were analysed for nitrogen (membrane, pore and matrix nitrogen⁴), calcium, magnesium, sodium and phosphorus. Analyses for carbonate, potassium, aluminium and iron were started but abandoned; the carbonate

Table 1

Property	Mean	Standard deviation
w_c (kgm.)	3.66 ± 0.042	± 0.802
t (mm.)	0.329 ± 0.002	± 0.0382
w_c/t (kgm./mm.)	11.06 ± 0.088	± 1.68
d/w (mm./kgm.)	0.0475 ± 0.00061	± 0.0117
d_c (mm.)	0.167 ± 0.0015	± 0.0287

Table 4

Shells	Vickers hardness number at level:						Per cent impressions with shattered regions	Average area of shattered regions (sq. μ)
	t	w_c/t	$1/t$	$1/t$	$1/t$	m		
Strong (10)	0.35	13.4	99	113	130	176	5.7	350
Weak (10)	0.31	9.0	95	105	116	130	16.2	440

* Parts for 100 parts of protein-free shell*

Shells	Ca	Mg	P	Na	Membrane protein	Pore protein	Matrix protein
Strong (10)	39.0	0.440	0.137	0.076	3.71	1.05	0.96
Weak (10)	38.9	0.386	0.141	0.069	4.01	1.13	0.98

* Percentage nitrogen = percentage protein $\times 0.14$

content was equivalent to the sum of the calcium and magnesium contents, and the amounts of the other cations present were judged to be too small to be important. The mean results are set out in Table 4; m denotes the gradient of hardness across the shell.

Statistical analysis showed that there was a highly significant difference between the hardness of the two sets of shells at all three levels. The gradient of hardness (m) across a shell was linear or nearly so, and it was significantly greater ($P < 0.01$) for strong shells. The softer a portion of the shell, the more brittle it tended to be; when impressions were accompanied by shattering, there was a significant correlation ($P < 0.01$) between the Vickers hardness numbers and the areas of shattering. The outer part of the shell is surprisingly hard, being comparable in this respect to mild steel². The hardness of the inner part of the shell resembled that of a sample of marble (mean Vickers hardness number, 98 kgm./sq. mm.); but it is doubtful if the comparison is a valid one since the lattices of the calcite grains of the shell, unlike those of marble, possess some degree of orientation with respect to the surface⁵, and it is known that the various lattice planes of calcite differ in hardness^{6,7}.

For comparative purposes, it is convenient to extrapolate the hardness values for each egg to the outer surface of the shell to give H . Correlation coefficients for the twenty shells are given in Table 5; much of the difference between these shells can be accounted for if it is assumed that w_c is proportional to both the thickness of the shell and the hardness of its outer layer. That other factors are also involved is suggested by the magnitude of the coefficients, and the fact that some unusually thick shells are weaker than would be expected from their hardness and thickness. The mean values of H_t were 144 and 125 for strong and weak shells, respectively.

Table 5

Relation	$w_c : t$	$w_c : H$	$w_c : t^2$	$w_c : tH$	$w_c : t^2H$
Coefficient (r)	0.249	0.740	0.825	0.906	0.891

Of the analytical values, only those for the magnesium content showed a significant difference ($P < 0.01$) as between the two sets of shells. The shells of eighteen 'average' eggs (range of $w_c/t = 11.0-11.6$) from the same batch were powdered and mixed; the mean magnesium content was 0.409 per

cent as against 0.440 and 0.386 per cent for unusually strong and weak shells, respectively.

If there is, in fact, a relation between strength, hardness and magnesium content, it would be expected that the gradient of hardness across the shell would be accompanied by a gradient of magnesium content. This was found to be so when shells were dissolved away in four or five successive layers with a mixture of perchloric acid and alcohol. The magnesium-calcium ratio decreased approximately logarithmically with increasing distance from the outer surface over about two-thirds of the thickness of the shell; thereafter, the gradient decreased. The inner third of the shell covers roughly the mamillary layer—which has a very different physical structure from the rest of the shell. The results of one experiment are set out in Table 6.

Table 6

Distance of centre of dissolved layer from inside of shell (thickness of shell = 100)	Mg/Ca ratio (values in gm.)
14	0.00605
38	0.00683
56	0.0103
73	0.0146
91	0.0196

These results are suggestive; but they do not prove that there is a direct connexion between magnesium content and the physical properties of the shell. As w_c/t tends to increase with increasing shell thickness (cf. Table 4) there will, in any event, be a tendency for the stronger shells to contain on the average a higher concentration of magnesium as a consequence of the gradient of magnesium content. It is true that dolomite is harder than calcite, and that magnesite is harder still⁸, but it is not known whether the magnesium in the shell is actually substituted for calcium in the lattice of the calcite grains. The atomic Mg/Ca ratio approached 0.048 at the surface of a thick shell, and this value is close to the limit (about 0.05) for the random-substitution series starting with calcite⁹. Nor is it known if substitution within these limits would account for the range of hardness observed in the shell. Other factors which may be important in this respect are the influence of grain-size and of the properties of grain-boundary films on hardness and brittleness⁸.

A detailed report of this work will be published later. We are indebted to Dr. J. Nutting and Mr. G. C. Smith, of the Department of Metallurgy, Cambridge, for much helpful advice, and to Dr. J. Wishart, in whose laboratory the statistical computations were made. Mr. A. Snow designed and made the loading apparatus; Mr. J. B. Monsey and Mr. N. R. King assisted in the experimental work. The work forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. [Jan. 10

¹ Romanoff, A. L., and Romanoff, A. J., "The Avian Egg" (Chapman and Hall, London, 1949).

² Tabor, D., "The Hardness of Metals" (Oxf. Univ. Press, Oxford, 1951).

³ Bernhardt, E. O., *Z. Metallkunde*, **33**, 135 (1941).

⁴ Tyler, C., and Geake, F. H., *J. Sci. Food Agric.*, **4**, 261 (1953).

⁵ Kelly, A., *Jenaische Z. f. Naturwiss.*, **35** (Neue Folge, 26), 429 (1901); Nilakantan, P., *Quar. J. Ind. Inst. Sci.*, **3** (2), 1 (1940).

⁶ Palache, C., Berman, M., and Frondel, C., "Dana's System of Mineralogy", 2 (Chapman and Hall, London, 1951).

⁷ Tertsch, H., *Mikroskopie*, **5**, 172 (1950).

⁸ Hall, E. O., *Proc. Phys. Soc.*, B, **64**, 747 (1951); *Nature*, **173**, 948 (1954). Gowan, E., *Z. Phys.*, **86**, 195 (1933).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Characterization and Genetics of Hæmoglobin G

IN the course of a survey of Gold Coast Africans¹, one individual was discovered who had both normal hæmoglobin and one hitherto not known which was designated as hæmoglobin G². Hæmoglobin G was found to differ from all other known hæmoglobins in its mobility on paper electrophoresis at pH 8.6 (veronal buffer). The hæmoglobins most similar in mobility were sickle-cell hæmoglobin (S), foetal hæmoglobin (F) and hæmoglobin D. S could in addition be differentiated by its low solubility when in the reduced state, and F by its resistance towards denaturation by alkali. For the distinction from hæmoglobin D, reliance had to be placed on the reported mobility of the latter, which was exactly that of S in open-boundary electrophoresis at acid and at alkaline pH³. Further steps have now been taken to establish the properties of hæmoglobin G.

Comparison between G and D. By the kindness of Dr. Sturgeon, a sample of hæmoglobin consisting of types A and D has been made available from a member of the Los Angeles family in which hæmoglobin D had originally been discovered⁴. This mixture had now been found to behave, as on open-boundary electrophoresis, so on paper electrophoresis at pH 8.6, exactly like a mixture of A and S⁵. It was possible to confirm that D behaved like S and differed from G under the conditions of our experiments.

Free-boundary electrophoresis. A mixture of hæmoglobins A and G has been examined both at pH 6.5 in cacodylate buffer and at pH 8.6 in veronal buffer. At acid pH good resolution occurs, and when the speed of migration of hæmoglobin G is measured, it lies between those observed for hæmoglobins A and S. If S is added to the AG mixture, difficulties are experienced in the resolution of G and S. No good resolution occurs between A and G at alkaline pH; but if S is added, there is good resolution between the AG mixture and S.

Family study. There is strong evidence that hæmoglobins A, S, G, D and E are the products of a single series of allelic genes, and that each of the two genes in the genotype is represented by part of the hæmoglobin in the red cells. It was therefore of interest to investigate the family of the propositus, J. R. A., on whom a brief report had appeared in 1954⁶. The mother had normal hæmoglobin only (genotype AA) and the father only hæmoglobin G (presumed genotype GG) (Fig. 1). The discovery of what appeared to be a homozygote was fortunate, because if hæmoglobin G was the product of a further allele of the series just mentioned, one would expect all the offspring of this homozygote to carry the abnormal hæmoglobin. He has eleven living children who are said to be legitimate, one of them being the propositus in whom hæmoglobin G was first found, and a number of extramarital offspring.

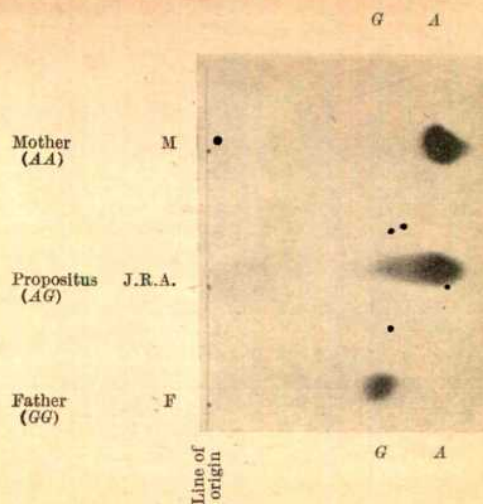


Fig. 1. Comparison of the hæmoglobin of the propositus J.R.A. (AG) with that of his father (GG) and his mother (AA). The cells were frozen after washing and packing. They were then lysed with water and the stroma was removed by shaking with toluene and centrifuging. The hæmoglobin solutions were examined by filter paper electrophoresis at pH 8.6. The technique followed was that of Smith and Conley (ref. 7). It will be seen that both parents are homozygotes, for A and G respectively

Of the ten living presumed full siblings of the propositus, nine were found to have hæmoglobin G (AG); but one was found to have the sickle-cell trait (AS). A family tree was obtained which ought to lead to the identification of further hæmoglobin G carriers.

The homozygote for G was not anæmic (hæmoglobin 13.9 gm./100 ml. blood), and there was no abnormality noticed in the red cell smear. There were 2 per cent reticulocytes and the serum bilirubin-level was within normal limits. It was not possible to detect foetal hæmoglobin, which is found almost invariably in homozygotes for S, and in a proportion of homozygotes for C.

Pure hæmoglobin G. It was of interest to examine the blood of the father more closely. There was no

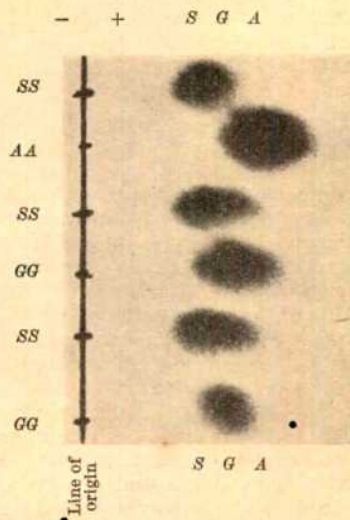


Fig. 2. Comparison by filter-paper electrophoresis at pH 8.6 (ref. 7) of hæmoglobins A, G and S prepared from the blood of homozygotes. It will be seen that G migrates faster than S and more slowly than A

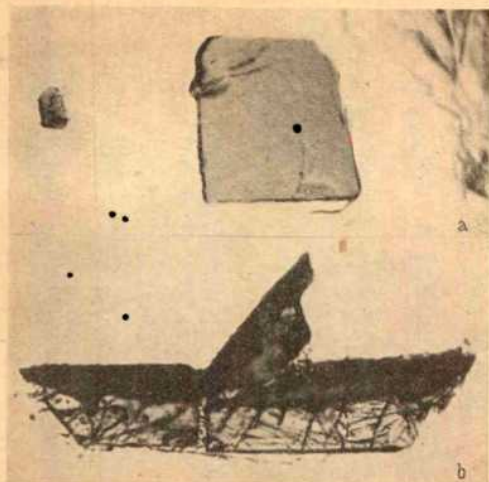


Fig. 3. (a) Isomorph birefringent crystal of pure haemoglobin *G* ($\times 90$). (b) Rhomboid non-birefringent crystal of haemoglobin *AG* ($\times 60$)

fetal haemoglobin present, and on paper electrophoresis the sample migrated as a single spot (Fig. 2). A spectroscopic examination was performed with the help of Mr. J. M. Campbell on a Unicam spectrophotometer lent by Sir Ernest Kennaway for the purpose. The haemoglobin from the mother of the propositus (*AA*) was compared with that of the father of the propositus (*GG*). No differences were found in the position of peaks of extinction of reduced *A* and *G*. For oxyhaemoglobin all peaks were identical with one exception; normal haemoglobin showed one at 4130 Å. and the homozygous *G* showed a corresponding one at 4140 Å. This difference was presumably due to small amounts of methaemoglobin present in both samples but at different concentrations. A number of derivatives of pure haemoglobin *G* were also examined at the Medical Research Council Spectrographic Research Unit by Dr. J. C. White and Dr. G. H. Beaven. They found no differences between *G* and *A*.

Solubility. The solubility of haemoglobin *G* tested by the method of Itano⁶ is considerably higher than that of haemoglobin *S* (> 5 gm. ferrohaemoglobin/litre, 2.24 *M* phosphate buffer); but seems to be either lower than that of haemoglobin *A* or within the lower part of the range of that haemoglobin (0.6 gm. ferrohaemoglobin/litre, 2.58 *M* phosphate buffer).

Crystals. Haemoglobin *G* and haemoglobin consisting of a mixture of *A* and *G* have both been obtained in crystalline form. The procedure was to prepare solutions of 5 gm. ferrohaemoglobin/litre in 2.24 *M* phosphate buffer as in the solubility test described by Itano⁶. At 25°C. the haemoglobin was fully soluble; but when the solution was allowed to remain for 24 hr. at 20°C., crystallization occurred readily (Fig. 3). It is hoped to examine these crystals further.

Haemoglobin *G* has thus now been compared by paper electrophoresis at pH 8.6 with all known variants of human haemoglobin and has been found to differ from them all. It seems to be inherited according to simple Mendelian principles, and a homozygote for *G* has been discovered.

One of us (H. L.) wishes to thank the Halley Stewart Trust for a grant towards the expenses of a visit to

the Gold Coast, and the Colonial Medical Research Committee for sponsoring the project.

G. M. EDINGTON

Medical Research Institute,
Accra, Gold Coast.

H. LEHMANN

St. Bartholomew's Hospital,
London, E.C.1.

ROSE G. SCHNEIDER

School of Medicine,
University of Texas,
Galveston, Texas.

¹ Edington, G. M., and Lehmann, H., *Trans. Roy. Soc. Trop. Med. Hyg.*, 48, 332 (1954).

² Edington, G. M., and Lehmann, H., *Lancet*, ii, 173 (1954).

³ Itano, H. A., *Proc. U.S. Nat. Acad. Sci.*, 37, 775 (1951).

⁴ Cooke, J. V., and Mack, J. K., *J. Pediatr.*, 5, 601 (1934).

⁵ Bergren, W. R., Sturgeon, P., and Itano, H. A., *Acta Haematol.*, 12, 160 (1954).

⁶ Itano, H. A., *Arch. Biochem.*, 47, 148 (1953).

⁷ Smith, E. W., and Conley, C. L., *Bull. Johns Hopkins Hosp.*, 93, 94 (1953).

Action of Ribonuclease and Ribonucleic Acid on Living Amœbæ

It has been shown¹ that ribonuclease strongly inhibits the incorporation of labelled amino-acids into the proteins of living onion root-tip cells. In order to extend these findings to animal organisms, the effects of ribonuclease and ribonucleic acid on living amœbæ (*Amoeba proteus*) have been studied.

Crystallized ribonuclease (G.B.I., 0.1 mgm./ml.) quickly inhibits the locomotion of amœbæ. After 90 min. they become almost spherical and, if left longer, they progressively cytolysed. If, after treatment with ribonuclease for 90 min., however, the amœbæ are returned to normal Chalkley's medium, they survive for many hours and attach themselves to the bottom of the dish; but most of them retain their spherical shape. If, on the other hand, they are transferred to Chalkley's solution containing 1.4 mgm. yeast ribonucleic acid (Schwarz, purified on column and neutralized) per ml., a variable proportion (10–40 per cent) of the amœbæ shows normal appearance and locomotion after a few hours. When ribonucleic acid (1.4 mgm./ml.) is present together with ribonuclease (0.1 mgm./ml.) in the medium, the amœbæ are remarkably protected: even after 18 hr. treatment they still stick to the bottom of the dish and appear healthy except for a strong retraction of the pseudopodia. Ribonucleic acid alone produces only a slight retraction of the pseudopodia. The enzymatically inactive oxidized ribonuclease has no, or little, effect on shape and locomotion.

Cytochemical observations with methyl green-pyronine staining show that the ribonuclease treatment produces a considerable loss of basiphily, both in the cytoplasm and the nucleoli; therefore the enzyme must penetrate quickly into the cell and its nucleus, which presents a swollen appearance (this penetration has been confirmed with radioactive ribonuclease and an autoradiographic method). When the amœbæ, after the ribonuclease treatment, are placed in normal medium for 18 hr., the cytoplasm is almost colourless, but the nucleoli often stain well with pyronin; it appears that resynthesis of ribonucleic acid, at the expense of free nucleotides, occurs



Track-autoradiographs of amoebae incubated in radioactive phenylalanine. (1) Control; (2) after treatment for 90 min. with ribonuclease; and (3) recovery in ribonucleic acid (18 hr.) after ribonuclease treatment

earlier in the nucleus than in the cytoplasm (cf. ref. 2). Most of the amoebae which, after ribonuclease treatment, have been placed in 1.4 mgm./ml. ribonucleic acid for 18 hr., show the same aspect; but 10–40 per cent of them now look normal in every respect. A mixture of all four nucleotides of yeast nucleic acid seems less effective than the nucleic acid itself in promoting this recovery. The ribonuclease-ribonucleic acid mixture which, as mentioned earlier, exerts no lethal action on the amoebae, nevertheless produces a very distinct drop in basiphily; the nuclei, however, remain practically normal. Treatment for 18 hr. with ribonucleic acid alone frequently induces an increase in the staining of the nucleoli.

A few experiments on amoebae which had been cut into nucleated and non-nucleated halves indicate that both halves lose their basiphily after the ribonuclease treatment; but recovery, on addition of ribonucleic acid, only occurs in the nucleated halves.

Quantitative estimation of the ribonucleic acid content in amoebae treated with ribonuclease (method of Linet and Brachet³) shows that after 90 min. it is reduced by 20–45 per cent; simultaneously, the free nucleotide content increases by 50–130 per cent. Amoebae treated with ribonuclease, when placed in plain Chalkley's solution, usually show, after 18 hr., a further drop in the ribonucleic acid content; but when the amoebae are put in 1.4 mgm./ml. ribonucleic acid, an almost normal ribonucleic acid content is found in those amoebae which have normal locomotion.

The next step was to study the incorporation of labelled ¹⁴C-phenylalanine in the various types of amoebae. Measurements with the Geiger-Müller counter showed only 30–45 per cent inhibition after treatment for the usual 90 min. with ribonuclease. But track-autoradiographs, kindly prepared by Dr. A. Ficq, showed that much of the radioactivity comes from radioactive contaminants outside the amoebae. As shown in Figs. 1 and 2, amoebae treated with ribonuclease (which have lost a large proportion of their basiphily) incorporate very little of the labelled amino-acid (inhibition 80–90 per cent). In amoebae which, after the action of ribonuclease, have been placed in the 1.4 mgm./ml. ribonucleic acid medium, three classes of amoebae can be found by autoradiography: (1) non-basiphilic amoebae, which incorporate little of the labelled phenylalanine (inhibition 80–90 per cent); (2) basiphilic amoebae

which, however, do not incorporate the amino-acid (inhibition 80–90 per cent); (3) basiphilic amoebae which incorporate labelled phenylalanine to an almost normal extent (inhibition 7 per cent; Fig. 3). These results suggest that the amoebae, after ribonuclease treatment, can utilize yeast ribonucleic acid, but that normal protein metabolism is only possible when this foreign nucleic acid has been converted into normal ribonucleic acid.

Finally, in six different experiments, each using fifty healthy amoebae, the organisms were cultivated, after various treatments, in the presence of micro-organisms suitable for feeding. The amoebae were re-counted every day; the sum total for all the experiments, after four to six days, is given in Table 1 (the general trend was the same in all six experiments).

Table 1. NUMBER OF AMOEBAE AFTER FOUR TO SIX DAYS. INITIAL NUMBER: 300

Control	Ribonuclease (0.1 mgm./ml.) 90 min. + Chalkley 18 hr.	Ribonuclease (0.1 mgm./ml.) 90 min. + ribo- nucleic acid (1.4 mgm./ml.) 18 hr.	Ribonucleic acid (1.4 mgm./ml.) 18 hr.
456 (+52%)	252 (-16%)	352 (+17%)	528 (+76%)

These experiments show that amoebae treated with ribonuclease are unable to multiply, although they are capable of feeding, as shown by cytological observations. Addition of ribonucleic acid, after the ribonuclease treatment, tends to restore the capacity to multiply in some amoebae. Cytological observation, at the end of the culture experiments, shows that some of the amoebae are perfectly normal, whereas others still retain a low basiphily. Furthermore, ribonucleic acid alone seems to exert a favourable effect on the multiplication of the amoebae.

A few culture experiments have also been carried out with amoebae treated with the ribonuclease-ribonucleic acid mixture: they show almost normal capacity for multiplication, except for an initial lag.

It can be concluded that, in amoebae, it is possible to modify almost at will the ribonucleic acid content of the organism within large limits: incorporation of amino-acid into the proteins and capacity to multiply are closely linked to the ribonucleic acid content. Such conclusions are in keeping with the

ideas expressed by Brachet⁴ and Caspersson⁵ on the role of ribonucleic acid in protein synthesis.

J. BRACHET

Laboratoire de Morphologie animale,
Université libre de Bruxelles.

March 1.

¹ Brachet, J., *Nature*, **174**, 876 (1954).

² Jeener, R., and Szafarz, D., *Arch. Biochem.*, **26**, 54 (1950).

³ Linet, N., and Brachet, J., *Biochim. Biophys. Acta*, **7**, 607 (1951).

⁴ Brachet, J., *Arch. Biol.*, **53**, 207 (1941).

⁵ Caspersson, T., *Naturwiss.*, **28**, 33 (1941).

Synthesis of Indole and Anthranilic Acid by Mutants of *Escherichia coli*

THE pathway of aromatic synthesis in bacteria has been determined mainly by nutritional studies and the accumulation of intermediates in cultures of mutants blocked at various metabolic steps. The biosynthesis of tryptophan probably involves the conversion of aromatic precursors such as shikimic acid through anthranilic acid and indole¹:



In the course of an investigation of the conversion of anthranilic acid to indole by bacteria, it was found that resting-cell suspensions of certain mutants of *Escherichia coli* would form indole from glucose and ammonium salts.

The mutants used in these experiments (Table 1) were derived from *E. coli* 518 (A.T.C.C. 9723) following ultra-violet irradiation and penicillin enrichment².

Cell suspensions were used immediately after preparation from cultures grown on a heart infusion agar medium, or on a solid synthetic medium³ with the appropriate growth factors added.

Mutant 1 required tryptophan for growth, but would not utilize indole. Presumably, therefore, it had a metabolic block between indole and tryptophan. The conditions under which mutant 2 forms indole when incubated in phosphate buffer with glucose and ammonium chloride are shown in Table 2. Indole synthesis by cells grown on the synthetic medium was stimulated (about seven-fold) by a heated extract of *E. coli* cells.

Table 1. MUTANT STRAINS OF *E. coli*; SUMMARY OF RESULTS

Mutant	Strain No.	Parent strain	Growth factor requirements*	Experiments with resting cells	
				Compound formed from glucose + ammon. chloride	Effect of serine on glucose-ammon. chloride system
1	7-4	518	Tryptophan	Indole	Stimulatory
2	72-15	7-4	Tryptophan + serine or glycine	Indole	Essential
3	1-5	518	Tryptophan or indole	Anthranilic acid	Stimulatory
4	Y3-23	1-5	Tryptophan or indole + serine or glycine	Anthranilic acid	Essential
5	7-8	518	Tryptophan or indole	Unidentified indole derivative	Stimulatory
Wild type	518 (A.T.C.C. 9723)		None	No detectable amounts of above compounds formed	

* Supplement needed for growth in minimal medium (ref. 3).

Table 2. INDOLE FORMATION: EFFECT OF SERINE

Substrate			Indole (mμ mole/mgm. dry wt.) formed by	
Glucose (0.1 M)	Ammon. chloride (0.005 M)	DL-serine (0.01 M)	Mutant 1	Mutant 2
+	—	—	37	44
+	+	—	212	61
+	+	+	280	274

Cells (mutant 1, 0.76; mutant 2, 1.04 mgm. dry wt./ml.) incubated with substrates in phosphate buffer (0.1 M, pH 7.7) for 3 hr. at 37°. Final volume, 5 ml. Cells grown on heart infusion agar.

Indole was estimated colorimetrically with *p*-dimethylamino-benzaldehyde by a modification of the method described by Wood, Gunsalus and Umbreit⁴. Spectrophotometric examination of the experimental samples confirmed the identity of the indole (Fig. 1).

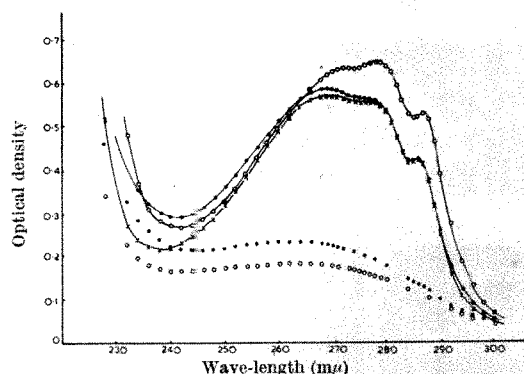


Fig. 1. Absorption spectra of compounds formed by mutants 1 and 5.

—x—x—, Synthetic indole in phosphate buffer (0.1 M, pH 7.7); ●—●—●, experimental sample containing indole formed from glucose and ammonium chloride by mutant 1 in phosphate buffer; ○—○—○, experimental sample containing unidentified compound formed by mutant 5. Unjoined circles show control samples from cells in phosphate buffer incubated with glucose only (●● = mutant 1; ○○ = mutant 5).

Various amino-acids added to the basal glucose-ammonium chloride system either inhibited indole synthesis or had no effect, with the exception of DL-serine, which stimulated the synthesis to a variable extent (15–50 per cent) (Table 2).

To assess the importance of serine in indole synthesis, a further mutant² was isolated from mutant 1. Mutant 2 required tryptophan and either serine or glycine for growth (Table 1). Washed cell suspensions of mutant 2 formed indole in the glucose-ammonium chloride system only when serine (or one of the related amino-acids, glycine, threonine or homoserine) was added. Furthermore, if mutant 2 was grown on a solid synthetic medium containing serine, only serine was effective in promoting formation of indole.

There was a lag before the maximum rate of synthesis of indole was attained. Cells of mutant 2 were allowed to become adapted, washed in buffer, and incubated with fresh substrates; there was then no lag in indole formation, but serine was still required. Thus serine is needed in indole synthesis for some reaction other than the formation of adaptive enzyme.

Mutant 3 (Table 1) required either indole or tryptophan for growth. Suspensions of this strain, when incubated with glucose and ammonium chloride under the conditions stated for indole synthesis, formed anthranilic acid (detected by fluorescence and absorption spectrum) at approximately the same rate as indole was formed by mutant 1. As with

indole, the addition of serine to the glucose-ammonium chloride system increased the amount of product formed. Mutant 4, requiring serine or glycine superimposed on the original requirements of mutant 3, was isolated (Table 1). Experiments with suspensions of mutant 4 indicated that serine was required for the formation of anthranilic acid.

Yet another mutant (No. 5) (Table 1) having the same nutritional requirements as mutant 3 was examined. Mutant 5 might have been expected to form anthranilic acid from glucose and ammonium chloride; but instead it formed an unidentified compound with an absorption spectrum (peaks at 278 and 287 m μ) typical of an indole derivative (Fig. 1). This compound differed from indole in ether solubility and by giving only a faint colour with *p*-dimethylaminobenzaldehyde. Serine stimulated the formation of this compound, and its significance in tryptophan synthesis is at present under investigation.

The main experimental findings are summarized in Table 1. It would appear that serine is a substrate for some reaction in the biosynthesis of indole. The actual stage or stages at which serine enters the reaction sequence is not yet known, but it seems that it is required for the synthesis of anthranilic acid.

We wish to thank the National Health and Medical Research Council for partial assistance and Prof. S. D. Rubbo for his encouragement. Strains 7-4 and 7-8 of *E. coli* were isolated by Mr. T. Holdaway during class experiments at the Biochemistry Department, Oxford.

F. GIBSON
MARJORIE J. JONES
H. TELTSCHER

School of Bacteriology,
University of Melbourne.

¹ Davis, B. D., Symp. Microbial Metabolism, 6th International Congress of Microbiology, p. 23 (1953).

² Davis, B. D., *J. Amer. Chem. Soc.*, **70**, 4267 (1948). Lederberg, J., and Zinder, N. J., *J. Amer. Chem. Soc.*, **70**, 4267 (1948).

³ Davis, B. D., and Mingioli, E. S., *J. Bact.*, **60**, 17 (1950).

⁴ Wood, W. A., Gunsalus, I. C., and Umbreit, W. W., *J. Biol. Chem.*, **170**, 313 (1947).

Specific Differences in the Nucleic Acids from A and B Strains of Influenza Virus

It has recently been found that influenza virus A, strain PR8, contains only ribonucleic acid, no appreciable amount of deoxyribonucleic acid being present. The amount associated with the virus is rather small, however, preparations of high infectivity ($LD_{50}/HA > 6.0$) containing between 0.8 and 1.0 per cent^{1,2}. Although preparations of low infectivity ($LD_{50}/HA \sim 3.2-4.5$) were found to have significantly lower ribonucleic acid contents², the

possibility still remained that the nucleic acid was not an integral part of the virus particle. A further method of investigating this possibility was to determine the overall ratios of the nucleic acid bases from different strains of influenza virus to see whether any relationship existed between the values obtained and any biological property, for example, serology. The preliminary results of such an investigation are reported here.

Six strains of virus were chosen—four A strains (PR8, MEL, WSE, SWINE) and two B strains (LEE, MIL). All strains were propagated in the allantoic cavity of 11-day old chick embryos, the allantoic fluid being harvested 30-42 hr. after inoculation of dilute seed virus. The viruses were purified by adsorption to, and elution from, human red cells, followed by two cycles of differential centrifugation³. The purity of the preparations was checked by examination in the analytical ultracentrifuge (kindly carried out by Mr. H. F. Holden) and by estimation of the number of haemagglutinin units per mgm. dry weight.

The nucleic acid was extracted from the defatted virus with hot 10 per cent sodium chloride solution, precipitated from the extract with two volumes of ethanol, washed, dried and digested with 1 N hydrochloric acid at 100° C. for 1 hr. The components were separated by paper chromatography in an *iso*-propanol - hydrochloric acid medium⁴ and estimated in an ultra-violet spectrophotometer⁴. In Table 1 are listed the proportion of the bases (referred to adenine) from the viruses, together with values of a ribonucleic acid sample isolated from an allantoic membrane homogenate (nucleotides separated by paper electrophoresis⁵) and values⁶ for the deoxyribonucleic acid isolated from a chick embryo homogenate.

A comparison of the virus preparations shows that the ratios of adenine + uracil to guanine + cytosine yield values which, even in the limited series of experiments presented, show a significant difference between the A and B strains. The values within the two categories are closely similar. This, then, constitutes perhaps the most definite evidence yet put forward that the ribonucleic acid is an integral part of the influenza virus particle⁶.

Of additional interest is a comparison of the virus values with those of the allantoic membrane ribonucleic acid (mainly cytoplasmic in origin) and the chick embryo deoxyribonucleic acid. Elson and Chargaff have stated that guanine and cytosine predominate in all ribonucleic acid samples (except yeast) studied in their laboratory, whereas adenine and thymine are the major components in most deoxyribonucleic acids⁷. In this respect, the virus nucleic acids show a marked difference, the ratios being in close agreement with the chick embryo deoxyribonucleic acid (thymine replacing uracil) but completely different from the membrane ribonucleic

Table 1. PROPORTIONS OF BASES IN THE NUCLEIC ACIDS OF A AND B STRAINS OF INFLUENZA VIRUS

Preparation	No. of experiments	Adenine	Ratios of bases referred to adenine			Adenine + uracil (thymine) Guanine + cytosine
			Guanine	Cytosine	Uracil (thymine)	
LEE (B)	4	10	8.0 $\pm$ 0.1	10.0 $\pm$ 0.3	15.5 $\pm$ 0.5	1.42 $\pm$ 0.04
MIL (B)	3	10	7.7 $\pm$ 0.2	10.4 $\pm$ 0.3	15.8 $\pm$ 0.2	1.43 $\pm$ 0.05
PR8 (A)	5	10	8.7 $\pm$ 0.2	10.4 $\pm$ 0.5	14.2 $\pm$ 0.13	1.27 $\pm$ 0.02
MEL (A)	2	10	8.3, 8.8	10.7, 11.3	13.3, 14.5	1.22 $\pm$ 0.01
WSE (A)	2	10	8.9, 8.9	10.8, 10.5	15.0, 14.3	1.26 $\pm$ 0.01
SWINE (A)	2	10	9.1, 8.8	10.9, 10.6	14.1, 14.5	1.24 $\pm$ 0.04
All membrane ribonucleic acid	1	10	16.6	14.0	10.3	0.67
Chick embryo deoxyribonucleic acid (ref. 5)		10	8.2	7.0	9.1	1.26

acid. Similar high ratios also characterize many of the plant virus nucleic acids studied⁷.

G. L. ADA
BEVERLEY T. PERRY

Walter and Eliza Hall
Institute of Medical Research, •
Melbourne. Feb. 21.

¹ Ada, G. L., and Perry, B. T., *Aust. J. Exp. Biol.*, **32**, 453 (1954).

² Ada, G. L., and Perry, B. T., *Nature*, **175**, 209 (1955).

³ Wyatt, G. R., *Nature*, **166**, 237 (1950).

⁴ Markham, R., and Smith, J. D., *Biochem. J.*, **49**, 401 (1951).

⁵ Davidson, J. N., and Smellie, R. M. S., *Biochem. J.*, **52**, 594 (1952).

⁶ Smith, J. D., and Stoker, M. G. P., *Brit. J. Exp. Path.*, **32**, 433 (1951).

⁷ Elson, D., and Chargaff, E., *Nature*, **173**, 1037 (1954).

⁸ Markham, R., "The Nature of Virus Multiplication", **85** (Cambridge, 1953).

Isolation of Kynurenine and 3-Hydroxykynurenine from Human Pathological Urine

In 1951, 3-hydroxyanthranilic acid was isolated from the urine of a patient with pulmonary tuberculosis after administration of L-tryptophan¹. This result caused us to examine the urine of various subjects, including some tuberculous patients not receiving special diet or supplementary administration of tryptophan. By means of paper chromatography it was found that the urine of normal humans contains very small quantities of 3-hydroxyanthranilic acid, while in eleven out of thirteen patients affected with pulmonary tuberculosis, excretion was definitely higher¹.

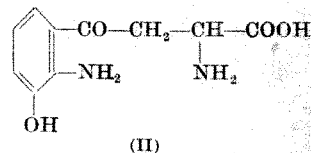
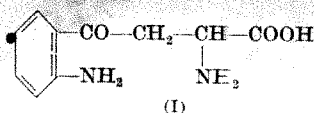
In a case of severe tuberculosis with a positive diazo reaction in the urine, Makino *et al.*² identified 3-hydroxykynurenine by paper chromatography, chromatic reactions and adsorption spectrum. More recently, Dalglish and Tekman³ found that in a large proportion of cases febrile humans excrete 3-hydroxykynurenine, and this excretion is, in particular, unrelated to tuberculosis or diabetes. It is attributed to a high rate of breakdown of body protein. We have been working for the past two years on the excretion of kynurenine and 3-hydroxykynurenine in pathological human urines. Preliminary results have been reported⁴. We can now report on the investigations as a whole.

So far, we have examined chromatographically the urine of 321 subjects: 32 normal persons, with normal feeding, ages 20–72, the remaining 289 in the various clinics of Padua (pulmonary tuberculous patients excluded) and given ordinary hospital diets.

The urine of normal humans, used as control, gave results that were negative. The urine of several patients was also negative; in many others a slight excretion of metabolites was noted, mainly kynurenine and xanthurenic acids, anthranilic and 3-hydroxyanthranilic acids and, sometimes, kynurenine and 3-hydroxykynurenine. Very often the result was not constant: it varied from day to day and, in every case, excretion was slight. Among these cases were twenty patients suffering from different forms of neoplastic diseases (cancer of skin, uterus, intestine, etc.). In six of these we found excretion of both kynurenines; in seven, kynurenine alone; and no metabolite in the others. This problem will be the subject of further researches.

We found a positive result in haemoblastic forms, as reported in Table 1.

Seventy-six cases were examined. In fifty-nine, kynurenine (I) and 3-hydroxykynurenine (II) (both free and conjugated) were found in considerable quantities,



besides small quantities of kynurenine and xanthurenic acids; in eleven cases kynurenine was present, but 3-hydroxykynurenine was absent. On the other hand, in six subjects, some of uncertain diagnosis, the kynurenines are absent; among these were also four patients treated with a colchicin derivative that we consider as probably inhibiting the excretion of the tryptophan metabolites.

All seventy-six patients have been followed from a minimum of three to a maximum of 120 days by means of chromatographic analysis. We have been able to confirm an important daily excretion of the kynurenines. The variations of body temperature, before and during the period in which the urine samples were taken, were noted from the clinical charts. From the cases examined it was observed that the excretion takes place during both normal and fever periods; it was also seen that the recession of the fever does not provoke the arrest of this excretion. The investigation was completed with the isolation of kynurenine and 3-hydroxykynurenine in the pure form.

We chose four cases from the Medical Clinic of the University of Padua: (1) chronic myeloid leukaemia; (2) and (3) Hodgkin's disease; (4) lymphoid leukaemia. Case (1): from nine litres of urine, 40 mgm. of kynurenine sulphate and 16.4 mgm. of 3-hydroxykynurenine were obtained. Case (2), 5.5 litres of urine gave 34 mgm. of kynurenine sulphate and 21.1 mgm. of 3-hydroxykynurenine. Case (3) (Hodgkin's disease with normal body temperature), 7.1 litres of urine gave 23.8 mgm. of kynurenine sulphate and 9 mgm. of 3-hydroxykynurenine. Case (4), 24.1 litres of urine gave 68.5 mgm. of kynurenine sulphate; 3-hydroxykynurenine was also present, but the amount was not sufficient to permit isolation. Analyses, ultra-violet spectra and chromatic reactions of compounds isolated agree completely with those described in the literature. Full results will be published elsewhere.

The quantities of the two substances originally present in the urine, calculated approximately by means of the ninhydrin colour method, were much higher than those actually isolated.

Table 1

Diagnosis	No. of cases excreting			Total
	kynurenine and 3-hydroxykynurenine	kynurenine alone	not excreting	
Myeloid leukaemia	23	5	4	31
Lymphoid leukaemia	19	5	2	26
Hodgkin's disease	14			14
Haemocytoblastic leukaemia	1			1
Histiocytic leukaemia	1			1
Lymphosarcoma	1			1
Multiple myeloma	1	1		2
Total	59	11	6	76

In earlier work by other authors on leukaemic urine, the only substance found was indirubin. Thus³, injecting extracts obtained from the urine of leukaemics into guinea pigs, it was possible to produce qualitative histological alterations similar to those characteristic of leukaemia. Other authors have repeated this experiment; but no definite results have as yet been achieved. It appears that leukaemic urine contains three times as much indirubin as normal urine⁴. It should be pointed out that indirubin has also been extracted from the urine of pregnant mares and, by one of us⁷, from the urine of rats and rabbits previously fed with fibrin.

An unknown substance that reacts with ninhydrin and which is occasionally present in various urines appears to have been found in leukaemics in higher concentrations⁷. Furthermore, Japanese scientists⁸ have reported that the urine of leukaemic patients reveals, by means of paper chromatography, the presence not only of known amino-acids but also of an unknown compound that is coloured by ninhydrin; this compound was found in twenty-seven out of twenty-nine patients and in four out of seventeen normal persons.

It is not easy, however, to correlate these observations with our findings concerning the isolation of the kynurenines. We would emphasize, however, that, hitherto, the extraction of tryptophan metabolites has been rare without the use of special diets or administration of tryptophan. It seems that in the human such excretion is linked with pathological conditions.

LUIGI MUSAJO
CARLO A. BENASSI
ANNA PARPAJOLA

Istituto di Chimica Farmaceutica,
Università di Padova,
Padova.
Jan. 5.

¹ Musajo, L., Spada, A., and Coppini, D., *J. Biol. Chem.*, **198**, 185 (1952).

² Makino, K., Satoh, K., Fujiki, T., and Kawaguchi, K., *Nature*, **170**, 977 (1952).

³ Dalglish, C. E., and Tekman, S., *Biochem. J.*, **51**, xiv (1953); **56**, 458 (1954).

⁴ Musajo, L., *Bull. Soc. Chim. Biol.*, **35**, 711 (1953).

⁵ Turner, D. L., and Miller, F. R., *J. Biol. Chem.*, **147**, 573 (1943); **161**, 91 (1945); *J. Nat. Cancer Inst.*, **14**, 439 (1953).

⁶ Friedman, E., Marrian, D. H., and Perutz, M. F., *Biochim. Biophys. Acta*, **1**, 45 (1946).

⁷ Musajo, L., *Gazz. Chim. Ital.*, **67**, 235 (1937).

⁸ Ishihara, I., Komori, Y., and Iida, H., *Nagoya J. Med. Sci.*, **14**, 149 (1951).

Cobalt Chloride and the Alpha-Cells of the Pancreas

THE hyperglycaemic glycogenolytic factor found in the pancreas of normal and of alloxan-diabetic animals was assumed to be the product of the α -cells of the Langerhans islets¹. When administered parenterally, simple cobaltous salts damage selectively the α -cells², and were therefore considered useful for investigating whether the hyperglycaemic factor meets the criteria of a hormone. Since administration of cobaltous salts also elicits a transitory hyperglycaemia^{2,3}, it has been suggested that they initially excite the α -cells, and then cause them to degenerate². This hypothesis is invalidated by the facts that animals treated with cobalt chloride do not become hypoglycaemic and that repeated injections evoke transitory hyperglycaemic responses even after the α -cells are no

longer demonstrable histologically³. Also, more of the hyperglycaemic factor could be extracted from the pancreas after such destruction of α -cells than from normal controls⁴. Ellis *et al.*⁵ found that dihydroergotamine inhibits hyperglycaemia caused by cobalt chloride, but not the effect of the hyperglycaemic factor.

While investigating the biological activity of a number of inorganic complexes⁶, it was found that some of them caused glycosuria in experimental animals. The blood-glucose level after the intraperitoneal injection of 120–150 μ gm. per gm. body-weight of *dl*-tris-ethylenediamine cobalt III chloride $[\text{Co}(\text{en})_3\text{Cl}_3]$ to starved albino rats showed the following characteristics; the blood glucose started to rise 15 min. after injection, reached its peak between 30 and 120 min., and returned gradually to normal within 4–4½ hr. without sinking below the initial level. The initial dose repeated three hours later caused a second peak in the blood-glucose curve, though these animals usually succumbed within a few hours to the toxic effect of the complex⁶. Animals which received daily doses of the complex showed unaltered reactions after each injection for a period of eight to fourteen days, after which they died. The height of the blood-glucose level after starvation was not affected by treatment on previous occasions. The rise in blood-sugar values after a single injection ranged from 40 to 200 mgm. per cent and was in no way proportional to the amount of complex administered.

The behaviour of the blood-glucose level after the injection of this complex had a striking similarity to that caused by simple cobaltous salts. Also, the amount of cobalt administered in a dose of cobalt chloride or of $\text{Co}(\text{en})_3\text{Cl}_3$ which caused a hyperglycaemic reaction was of the same order. However, the relevance of this finding is not at present clear, since its implication that the cobalt ion itself is the hyperglycaemic agent is not tenable for the following reasons. The $\text{Co}(\text{en})_3^{3+}$ ion is a co-ordinately saturated and extremely stable complex, with a stability constant⁷ of 10^{47} . It has been shown previously that the biological activity of many stable complexes is a function of the cation as a whole and not of the metallic atom⁸. Also, similar complexes containing different metals (see Table 1) showed a hyperglycaemic activity of the same type as the $\text{Co}(\text{en})_3^{3+}$ ion.

Table 1. EFFECT OF COBALT CHLORIDE, INORGANIC METAL COMPLEXES AND COBALT CHLORIDE + AMINO-ACID MIXTURES ON BLOOD-GLUCOSE LEVEL AND PANCREATIC α -CELLS

Compound administered	Route of administration	Behaviour of blood-glucose level	Condition of α -cells
CoCl_2	Intraperitoneal or intravenous	Hyperglycaemia	Absent
$\text{Co}(\text{en})_3\text{Cl}_3$	"	"	Normal
$\text{Co}(\text{NH}_3)_6\text{Cl}_3$	"	"	"
Tris-glycine CoIII	Intraperitoneal	"	"
$\text{Rh}(\text{en})_3\text{I}_3$	"	"	"
$\text{Os}(\text{en})_3\text{Cl}_3$	"	"	"
CoCl_2 + <i>dl</i> -methionine	Intraperitoneal or intravenous	"	"
" " + <i>l</i> (+)-histidine HCl	"	"	"
" " + <i>dl</i> -alanine	Intraperitoneal	"	Not determined
" " + <i>l</i> (+)-arginine HCl	"	"	"
" " + <i>dl</i> -leucine	"	"	"

The hyperglycaemic responses to the above compounds show the same individual variations as to the ethylenediamine-cobalt ion and cobalt chloride. The pancreatic sections were stained by Gomori's method (ref. 8).

Histological sections prepared from the pancreas of rats and rabbits which received either single injections of, or prolonged treatments with, the complexes revealed that none of them caused any recognizable damage to the α -cells of the islets of Langerhans.

It was found that the complex of trivalent cobalt with glycine caused hyperglycaemia. Since the cobaltous ion would readily form complexes with the free amino-acids of the serum, it was considered of interest to test whether complexes of cobaltous ions and amino-acids also showed a similar activity. The solutions of amino-acids (see Table 1) were neutralized and mixed with cobalt chloride. These mixtures, which contained cobalt chloride and amino-acid in the ratio of 1:3 (in a few instances 1:6), were given intravenously to rabbits. Histological sections were prepared from the pancreas of rabbits which received cobalt chloride plus methionine, and cobalt chloride plus histidine. Although the mixtures exhibited the same hyperglycaemic activity, none of the sections examined showed any damage to the α -cells of the pancreas.

These results suggest that the hyperglycaemic action of cobalt chloride and its effect on α -cells of the pancreas are two independent phenomena. The mechanism of the hyperglycaemic action of the complexes and cobalt chloride is being further investigated.

I am indebted to Drs. E. C. Gyrfas and F. P. Dwyer for the preparation and supply of inorganic complexes used in this work.

J. H. KOCH

McMaster Animal Health Laboratory,
Division of Animal Health and Production,
Commonwealth Scientific and
Industrial Research Organization,
Parramatta Road,
Glebe, N.S.W.
Nov. 23.

¹ Sutherland, E. W., and de Duve, C., *J. Biol. Chem.*, **175**, 663 (1948).

² Van Campenhout, E., and Cornelius, G., *C.R. Soc. Biol., Paris*, **14b**, 933 (1951).

³ Goldner, M. G., Volk, B. W., and Lazarus, S. S., *Metabolism*, **1**, 544 (1952).

⁴ Fodden, J. H., and Read, W. O., *Endocrin.*, **54**, 303 (1954).

⁵ Ellis, S., Anderson, jun., H. L., and Collins, M. C., *Proc. Soc. Exp. Biol., N.Y.*, **84**, 383 (1953).

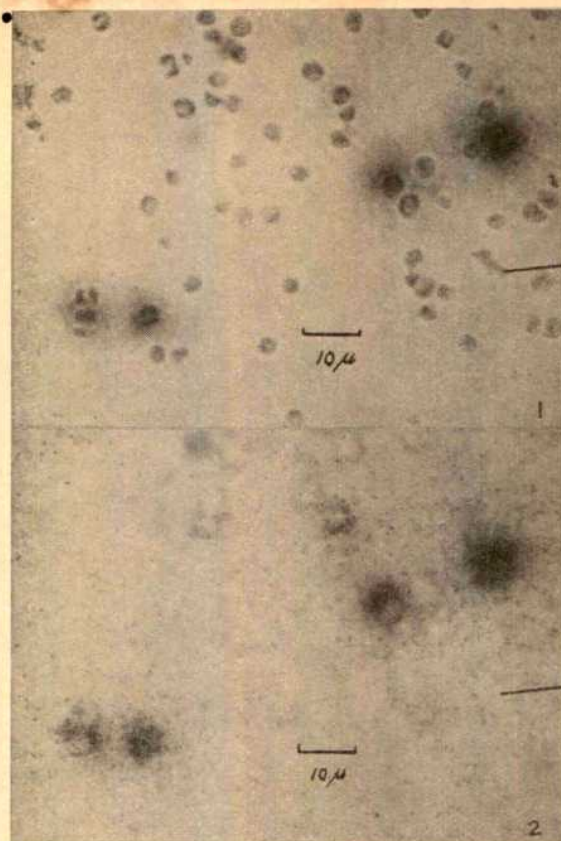
⁶ Dwyer, F. P., Gyrfas, E. C., Rogers, W. P., and Koch, J. H., *Nature*, **170**, 190 (1952).

⁷ Bjerrum, J., "Metal Ammine Formation in Aqueous Solution" (P. Haase and Son, Copenhagen, 1941).

⁸ Gomori, G., *Amer. J. Path.*, **17**, 395 (1941).

High-resolution Autoradiography of Water-soluble Substances

THE stripping-film technique of Pele¹ for the autoradiography of radioactive substances incorporated in microscopic sections requires that the film should be put on in water. Consequently the method cannot be applied directly to the location in tissues of substances which are soluble in water. Chapman-Andresen² has kept such substances from moving by covering the tissue with a thin film of nylon or other material. This technique is suited for the restripping process in which the emulsion is separated from the tissue before development and examined separately, but is less suited to the direct simultaneous examination of the section and radiograph, which avoids the possibility of reorientation and change of scale. Although the resolution obtainable by the stripping-film technique depends very critically on the distance



(1) *Chlorella* cells viewed through the radiograph film. (2) The same field as (1), a higher focus, showing the autoradiograph

between the tissue and the photographic emulsion, Chapman-Andresen claims that resolution is unaffected by the films used.

In the course of studies on ion accumulation, I have developed a technique for mounting the stripping film on the tissue section without the necessity of interposing other films, and without allowing water-soluble substances in the section to move. The stripping film is removed from its plate and allowed to swell on water in the usual way. It is removed from the water, rinsed in dry chloroform, and arranged on the slide bearing the tissue in a fresh bath of dry chloroform, emulsion side down. The film is then dried rapidly in absolute alcohol, followed by a draught of cool air. After exposure, the film is examined microscopically through the photographic film. Aggregates of silver grains are visible in the emulsion over those parts of the tissue which contained radioactive substances during exposure. The resolution obtainable with water-soluble substances by this method is as good as that for insoluble substances by the normal method.

The preparation of the tissue section must be made with care to preserve the position of the water-soluble substances. Each tissue to be examined presents its own problem. The cells, radiograph of which are shown (Figs. 1 and 2), were prepared by freeze drying and injecting straight from the vacuum with dry chloroform. No sectioning was necessary.

By this technique a feature of accumulation by unicellular organisms has been revealed. Cells of *Chlorella pyrenoidosa* were grown in the light for thirty minutes in a medium containing strontium-90

ions. The radiograph shows that a few cells only have taken up strontium. These cells appear to be dividing. The high energy of beta-emissions from strontium-90 and the daughter isotope yttrium-90 is probably limiting resolution.

M. J. CANNY

Botany School,
Cambridge.
March 8.

¹ Pelc, S. R., *Nature*, **160**, 749 (1947).

² Chapman-Andresen, C., *C.R. Trav. Lab. Carlsberg, Ser. Chim.*, **28**, 529 (1953).

Display of Pulse Intervals in Neurophysiological Experiments

IN electrophysiological investigations of nerve impulse activity, an analysis of the intervals between individual potentials is often useful. The conventional method of determining such intervals by reading off each of them against the time-scale of the tracing is, however, a very tedious procedure and, besides, the cost of film run continuously at the rather high speed required is not negligible in extensive investigations. Methods permitting a more direct survey of the results, preferably during the course of the actual experiment, are therefore highly desirable in neurophysiological work.

When studying processes in which the interval between successive impulses changes only slowly, at a more or less constant rate, satisfactory results can be obtained by the use of counting-rate meters of conventional design. Such an instrument¹, directly indicating the frequency per second of the impulse discharge studied, coupled to an ink-writer for continuous recording of the frequency variations, has proved to be of great value for the exploration of the discharge patterns of single units of the central nervous system². However, a rate meter of this type, based on an integrating network exhibiting a time constant, is not able to follow rapid variations in pulse intervals, and a complementary method has therefore been developed which permits an easy survey of the spacing of the individual nerve impulses. Although the apparatus has certain limitations in comparison with the elaborate pulse-interval meter recently described by Andrew and Roberts³, it has the advantage of being simple, as appears from the block diagram Fig. 1.

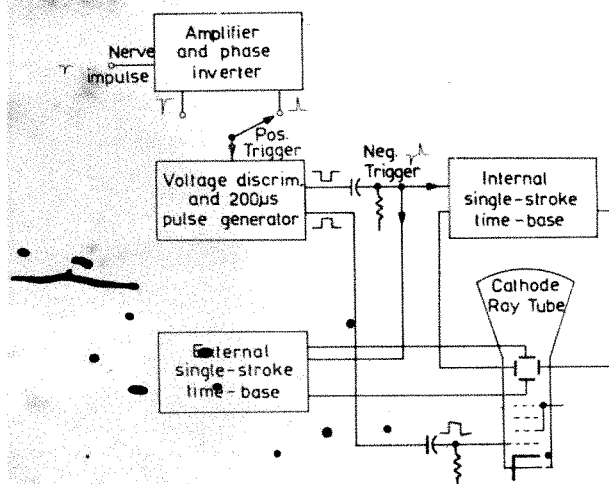


Fig. 1. Block diagram of display unit

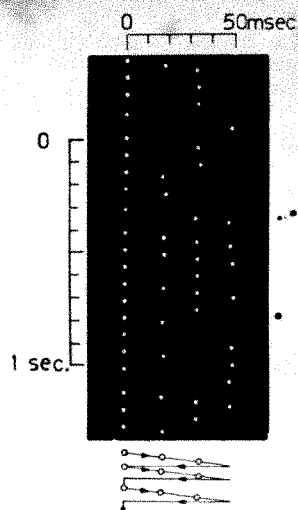


Fig. 2. Recorded impulse pattern from a proprioceptive nerve fibre. The first impulse is that in the top left-hand corner. The sequence is indicated by the arrows below showing the movement of the cathode ray. The vertical separation of successive horizontal sweeps is not constant but depends on variations in the impulse patterns (see text)

The oscillograph is provided with facilities for brightness modulation and for single-stroke sweep operation along the X-axis. A slow external, single-stroke, sweep circuit is connected to the Y-plates. The intensity control of the oscillograph is set low so as to suppress the spot. The train of nerve impulses to be investigated is passed through an amplitude discriminator producing one square wave pulse of a few hundred microseconds duration for each incoming impulse exceeding a pre-set amplitude. The first pulse in the train triggers both the horizontal and vertical time-base, and each pulse modulates the intensity of the cathode ray, thereby producing a series of bright spots on the screen. When the first horizontal sweep is completed, the cathode ray moves rapidly back to the left and is ready to be triggered by a following pulse. Due to the continuous slow vertical sweep movement, a pattern of spots appears on the screen, the distance between successive spots along a single horizontal sweep being a measure of the impulse intervals. By varying the speed of the horizontal sweep, a suitable number of impulses can be made to appear on each sweep. The termination of the slow vertical sweep completes one operation of sampling a train of nerve impulses. It will be noted that one interval is lost between successive horizontal sweeps; this is, however, insignificant for many types of analysis, since a simultaneous check on the average frequency is obtained by the use of a counting-rate meter.

A cathode-ray tube with a long-persistence screen allows of a rapid survey of the intervals during the actual experiment. As the start of each horizontal sweep is always synchronized with the arrival of a nerve impulse, a mere glance at the configuration of the spots on the screen is sufficient to reveal pertinent facts concerning the interval variations. Thus, for example, a pattern in which the spots tend to be grouped in vertical rows indicates similar intervals or multiples of these intervals, as illustrated in Fig. 2, whereas a progressive change in intervals is shown up by oblique rows; on the other hand, random spacing of the nerve impulses is indicated by the absence of any such regular pattern.

The simplest way of recording the pattern is to photograph the horizontal sweeps on a vertically moving film running continuously at slow speed, with the external (vertical) time-base circuit disconnected.

L. HAAPANEN
C. R. SKOGLUND

Department of Physiology,
Karolinska Institutet,
Stockholm.
Feb. 18.

¹ Elmore, W. C., and Sands, M., "Electronics", 249 (McGraw-Hill Book Co., New York, 1949).

² Kolmodin, G. M., and Skoglund, C. R., *Experientia*, 10, 505 (1954).

³ Andrew, A. M., and Roberts, T. D. M., *Electronic Eng.*, 28, 469 and 543 (1954).

A Sensitive Method for the Estimation of Hydrogen Peroxide in Biological Materials

DURING recent years a number of methods for the estimation of hydrogen peroxide which utilize the principle of coupled oxidation have been published. Catalase or peroxidase combines with hydrogen peroxide as it is liberated, and the complex thus formed then brings about the oxidation of such substances as nitrite¹, ethanol², cytochrome c³, or manganese ions in presence of *p*-cresol⁴. The extent of these oxidations may be measured by manometric, colorimetric or spectrophotometric means. The method of detecting hydrogen peroxide to be described is based on the same principle but has the advantage of greater sensitivity. In this case the disappearance of the fluorescent peroxidase substrate scopoletin (6-methyl-7-hydroxy-1:2-benzopyrone) is observed with the aid of a suitable fluorometer. The Beckman spectrophotometer model DU used as for the estimation of fluorescence in solution (Beckman Bull. 149-G) was found satisfactory, a concentration of 2×10^{-10} mole per ml. giving a reading of 100 divisions on the intensity scale with the instrument adjusted to its highest sensitivity. Up to 2.5×10^{-9} mole per ml., the intensity of fluorescence is proportional to the concentration of scopoletin (Fig. 1).

An aqueous solution of scopoletin is reasonably stable in diffused light and is not oxidized by either peroxidase or hydrogen peroxide alone. However, if peroxidase and hydrogen peroxide are both added, oxidation with loss of fluorescence proceeds very

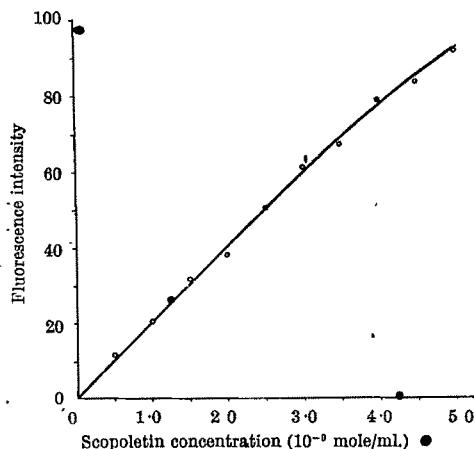


Fig. 1. Fluorescent intensity of scopoletin solutions at concentrations up to 5×10^{-9} mole per ml. in borate buffer pH 10

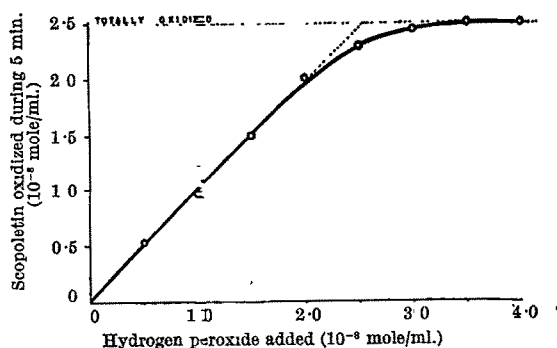


Fig. 2. Relationship between the quantity of hydrogen peroxide and the amount of peroxidative oxidation of scopoletin. Reaction mixtures contain per ml. 2.5×10^{-8} mole scopoletin, hydrogen peroxide as indicated in the figure and aqueous extracts of dehydrated horse radish at pH 4.5

rapidly. Fig. 2 shows the quantitative relationship between the amount of hydrogen peroxide added and disappearance of scopoletin. In this experiment each reaction mixture was made up to 1 ml. and contained an aqueous extract of commercial dehydrated horse radish at pH 4.5, 2.5×10^{-8} mole of scopoletin and varying amounts of hydrogen peroxide. After a few minutes, 9.0 ml. of borate buffer (pH 10) was added and the residual scopoletin fluorescence measured. Precisely one mole of hydrogen peroxide was required for the oxidation of one mole of scopoletin. This simple stoichiometry applied so long as the scopoletin was present in about 20 per cent excess.

The experiment was repeated using metabolically produced hydrogen peroxide. Pea epicotyl juice contains a diamine oxidase which produces one mole of hydrogen peroxide per mole of putrescine oxidized⁵. It also contains a peroxidase. Fig. 3 illustrates the effect of time on the oxidation of scopoletin by pea epicotyl juice (pH 6.8) when enzymatic oxidation of putrescine contributes the necessary hydrogen peroxide. In this experiment 1.2×10^{-8} mole of putrescine was added to a ten-fold excess of scopoletin. The reaction commenced immediately but proceeded slowly, coming to completion within 11 min. About 80 per cent of the predicted amount of scopoletin was oxidized. On a second addition of 1.2×10^{-8}

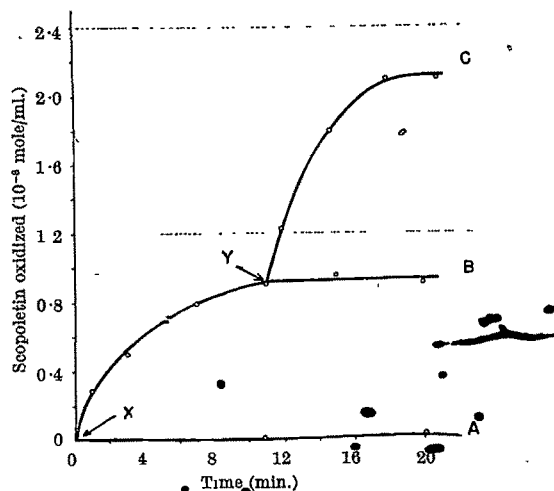


Fig. 3. Rate of oxidation of scopoletin (1.2×10^{-8} mole per ml.) by pea juice pH 6.8 with putrescine as source of endogenous hydrogen peroxide (curve A). Additions: curve B, 1.2×10^{-8} mole putrescine (at X); curve C, a second addition of 1.2×10^{-8} mole putrescine 11 min. later (at Y)

mole of putrescine, the reaction was faster and oxidation of the theoretical amount of scopoletin took place. When equivalent amounts of hydrogen peroxide were added to the reaction mixture instead of putrescine, it was found that only 66 per cent of the theoretical amount of scopoletin oxidation occurred. Similarly, a second addition of hydrogen peroxide resulted in the theoretical amount of oxidation. Apparently there are present in pea juice alternative peroxidase substrates which may interfere, especially in the more alkaline pH ranges. For this reason it sometimes becomes necessary to remove these interfering substances by a preliminary oxidation before proceeding with the quantitative estimation of hydrogen peroxide production.

A number of reducing substances are capable of competitively inhibiting the oxidation of scopoletin by peroxidase; for example, ascorbic acid, glutathione and manganous ions. Consequently other fluorescent phenolic coumarin derivatives were investigated. Esculetin is more readily oxidized by peroxidase than is scopoletin, and ascorbic acid does not interfere, but unfortunately its fluorescence is relatively weak and, moreover, its oxidation by molecular oxygen is catalysed by polyphenol oxidase (scopoletin is not oxidized by polyphenol oxidase over a period of four hours). On the other hand, umbelliferone is resistant to peroxidative oxidation. Scopoletin therefore appears to be the best fluorescent indicator so far found for the peroxidative estimation of hydrogen peroxide. After interfering substances have been removed by a preliminary oxidation, amounts of endogenously produced hydrogen peroxide in the range of 10^{-10} mole can be determined quantitatively. This represents a hundred-fold increase in sensitivity over previous methods. The limitations of available analytical procedures are in large part responsible for the paucity of information of hydrogen peroxide metabolism in plant and animal tissues. This new method incorporates features which make it particularly suitable for biological investigations.

W. A. ANDREAE

Science Service Laboratory,
University Sub-Post Office,
London, Ontario.

Dec. 23.

¹ Thurlow, S., *Biochem. J.*, **19**, 175 (1925).

² Keilin, D., and Hartree, E. F., *Proc. Roy. Soc. B*, **119**, 141 (1936); *Biochem. J.*, **39**, 293 (1945).

³ Altschul, A. M., Abrams, R., and Hagness, T. R., *J. Biol. Chem.*, **136**, 777 (1940); **142**, 303 (1942).

⁴ Kenten, R. H., and Mann, P. J. G., *Biochem. J.*, **45**, 255 (1949); **46**, 67 (1950); **51**, 360 (1951).

The Primary Photochemical Process in Bromine

THE absorption spectrum of bromine exhibits a continuum which commences at about 5107 Å., and it is known that the absorption of light of wavelength less than this value causes the dissociation of bromine into an atom in its normal $^2P_{3/2}$ state and one in the excited $^2P_{1/2}$ state. Photochemical studies have shown that bromine molecules are also dissociated when irradiated with light of wavelengths greater than 5107 Å. Thus the quantum yield of the hydrogen-bromine reaction¹ is approximately the same at 5460 Å. as for light of wavelength in the continuum, that is, 5107 Å. Further, it has been demonstrated that the quantum yield^{2,3}

for the photobromination of ethylene is independent of wave-length between the limits 4800 and 6800 Å.

Two theories have been proposed to explain this constant quantum yield for light with wave-length in the discrete region of the bromine spectrum. Jost¹ suggested that the excited bromine molecules formed by the absorption of radiation with wave-length in the banded region of the spectrum dissociate with high yield into normal ($^2P_{3/2}$) atoms on collision with other molecules. Kistiakowsky and Sternberg² have controverted this point of view and instead suggest that the absorption of light at the longer wave-lengths is largely due to bromine molecules possessing some vibrational energy due to thermal excitation. The main evidence in support of this new theory comes from measurements of the temperature variation of the coefficients of absorption of light for bromine. In this communication it is shown that theoretical calculations of the temperature variation of the absorption of light by vibrationally excited bromine molecules yield results in good agreement with the experimental data of Kistiakowsky and Sternberg.

The intensity of absorption of light of frequency ν is given by the formula:

$$I_{\text{abs.}}^{\nu'\nu''} = \frac{8\pi^3}{3hc} I_0 \Delta x N_{\nu''} \nu |R^{\nu'\nu''}|^2 \quad (1)$$

where I_0 is the intensity of the incident radiation, Δx is the thickness of the absorbing layer, $|R^{\nu'\nu''}|$ is the matrix element for the transition between the electronic states with vibrational levels ν' and ν'' , and $N_{\nu''}$ is the number of molecules in the vibrational level ν'' of the ground-state. $N_{\nu''} = N \frac{\exp \{-G_0(\nu'')hc/kT\}}{f}$

where f is the partition function, and $G_0(\nu'') = \omega_0 \nu'' - \omega_0 x_e \nu''^2 + \omega_0 y_0 \nu''^3 \dots$, $\omega_0 = \omega_e - x_e \omega_e + 3\omega_e y_e/4 \dots$, and $\omega_0 y_0 = \omega_e y_e \dots$. Since with Kistiakowsky and Sternberg³ we suppose that the absorption of radiation by the vibrationally excited bromine molecules leads to dissociation, it is easy to see that the ratios of the absorption coefficients at two different temperatures T_1 and T_2 , for light of a given frequency, are:

$$I(T_2)/I(T_1) = N_{\nu''}(T_2)/N_{\nu''}(T_1) = \frac{\exp \{-G_0(\nu'')hc(T_1 - T_2)/kT_1 T_2\}}{\exp \{-G_0(\nu'')hc(T_1 - T_2)/kT_1 T_2\}} \quad (2)$$

For the ground $^1\Sigma_g^+$ state of bromine⁴, $\omega_e = 323.2$ cm.⁻¹ and $\omega_e x_e = 1.07$ cm.⁻¹; $\omega_e y_e$ is unknown but can be neglected. Using these spectroscopic constants, the ratio $I(422.1^\circ \text{K.})/I(308.1^\circ \text{K.})$ has been calculated for bromine molecules excited in various vibrational levels of the ground-state. Table 1 gives the results of these calculations and shows also the values calculated from the experimental data of Kistiakowsky and Sternberg.

The agreement between the two sets of values is particularly good in the case of the $\nu'' = 3$ level, and the general concordance between the theoretical and the experimental values for these three levels must

Table 1. ABSORPTION COEFFICIENTS FOR VIBRATIONALLY EXCITED BROMINE MOLECULES

ν''	$G_0(\nu'')$ cm. ⁻¹	$I(422.1)/I(308.1)$ Calculated	Experimental
1	321.03	1.49	1.11
2	639.93	2.23	1.7
3	956.76	3.82	3.46

be taken as supporting evidence for the Kistiakowsky and Sternberg theory.

C. A. McDOWELL

Department of Inorganic and Physical Chemistry,
University of Liverpool.

Dec. 8.

¹ Jost, W., *Z. phys. Chem.*, 134, 92 (1928); B3, 95 (1929).

² Schmitz, H., Schumacher, H. J., and Jäger, A., *Z. phys. Chem.*, B1, 281 (1942).

³ Kistiakowsky, G. B., and Sternberg, J. C., *J. Chem. Phys.*, 21, 2218 (1953).

⁴ Herzberg, G., "Spectra of Diatomic Molecules" (2nd edit., Van Nostrand and Co., New York).

A Relation between Hardness and Stoichiometry in Lead Sulphide Single Crystals

IN the course of an investigation concerning the semiconducting properties of lead sulphide, single crystals were prepared and reheated under various sulphur pressures at 1,200° K. in order to control the deviations from the exact stoichiometric composition. The concentration of impurities in these crystals was less than 10^{17} cm.⁻³ (5×10^{-6} atom per mole lead sulphide).

When equilibrium with the ambient gas atmosphere had been reached, the crystals were rapidly cooled to room temperature and the concentration of free-charge carriers was determined by measuring the Hall coefficient.

From these experiments the conclusion was drawn that introduction of excess lead into the crystal on a lattice site causes the formation of a sulphur ion vacancy (anion vacancy, V_A). Of the two electrons given off by the lead atom (when giving a Pb^{2+} ion), the first remains trapped at the positively charged sulphur vacancy and the second one is so weakly bound to the resulting V_A^- centre that at room temperature it behaves as a 'free' electron. Similarly, introduction of extra sulphur atoms gives rise to an equal concentration of lead vacancies that have trapped a hole (V_C^+) and free holes. In Fig. 1 the concentrations of free charge carriers (corresponding to the concentration of cation and anion vacancies) are plotted against the pressure of sulphur vapour in which the crystals had reached their equilibrium.

The hardness of these crystals was measured under a 100-gm. load and is given in the Vickers scale, Fig. 2.

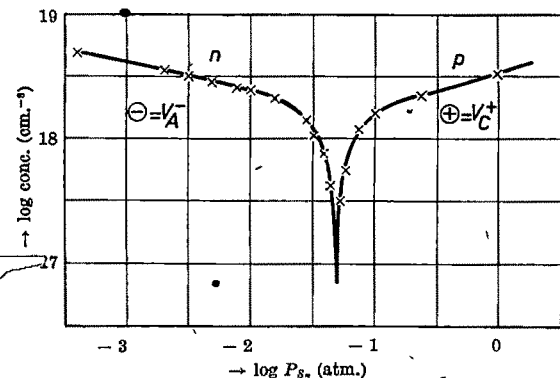


Fig. 1. Concentrations of free electrons and holes (being equal to the concentrations of sulphur vacancies, V_A^- , and lead vacancies, V_C^+ , respectively), measured at room temperature on lead sulphide single crystals after reheating under various partial pressures of sulphur (P_{S_2}) at 1,200° K.

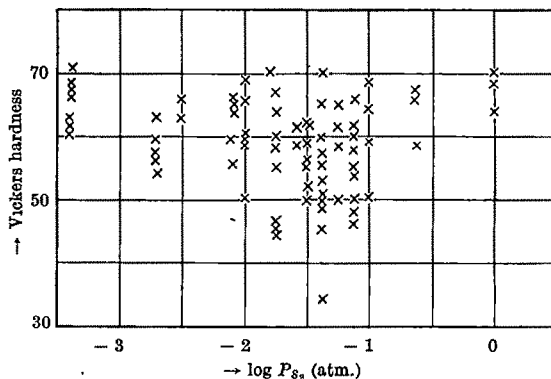


Fig. 2. Hardness, measured on cleavage planes of lead sulphide single crystals after reheating at 1,200° K. under various sulphur pressures

The results show considerable scatter, but it seems justified to conclude that among the stoichiometric crystals ($\log P_{S_2} = -1.4$ atm.) there are crystals showing a minimum hardness (about 40–50 Vickers); this is not the case for strong *n*- and *p*-type crystals, prepared by reheating at lower or higher sulphur pressures.

The results suggest that, although several other factors undoubtedly play a part in increasing the hardness, the concentration of vacancies is of importance, a low concentration being a necessary condition for the observation of a low hardness.

J. BLOEM

F. A. KRÖGER

Philips Research Laboratories,
N.V. Philips' Gloeilampenfabrieken,
Eindhoven.

Dec. 10.

Solution of Elastic Vibration Problems with the Resistance-Network Analogue

THE vibration of an elastic plate is described by the equation:

$$\nabla^4 w = a^2 \nu^2 w \quad (1)$$

where the symbol ∇^4 stands for the operator $\frac{\partial^4}{\partial x^4} + 2 \frac{\partial^4}{\partial x^2 \partial y^2} + \frac{\partial^4}{\partial y^4}$, $w = w(x, y)$ is the displacement, a a constant describing the elastic properties of the plate, and ν the frequency of vibration.

It was shown in a previous communication¹ that the equation:

$$\nabla^4 w = f \quad (2)$$

where $f = f(x, y)$ is a known function of the coordinates x and y , can be solved by a resistance-network analogue comprising two resistance-networks in cascade. The function f is represented in the analogue by the currents fed in at the 'upper' network of the network cascade, and the function w by the voltages appearing at the mesh nodes of the 'lower' network.

It has also been demonstrated^{2,3} that oscillation problems of the form:

$$\nabla^2 \varphi = -\kappa^2 \varphi \quad (3)$$

where κ^2 is a characteristic value parameter, can be solved by combining the resistance-network technique of solving Laplace- or Poisson-type problems with an iterative method in which the currents fed into the network junctions are cyclically readjusted until

a 'self-consistent' solution, satisfying equation (3) at all mesh nodes, has been established. In practice, four to six iteration cycles are required to reduce the numerical errors of the analogue solution of equation (3) to rather less than the truncation error of the solution due to the finite, and often relatively small, number of mesh points used.

This iterative process of finding a characteristic value can be applied to the solution of equation (1). The only difference is that now it is no longer the current and voltage at the same network junction which are compared and made to satisfy a certain relation to each other, but the current flowing into a network point in the upper network is correlated with the voltage appearing at the corresponding junction of the lower network. This requires modifications of some details of the iteration process previously described³, but does not introduce any major changes in technique. However, as in solutions of the biharmonic equation, the mixed boundary conditions which can appear in elastic plate problems can present severe difficulties.

Fig. 1 shows, as an illustration of the method by a one-dimensional example, the analogue solution of a vibrating uniform steel rod cantilever of 1 in. diameter and of length $l = 50$ in., the rod being clamped at one end (that is, $w = 0$ and $dw/dx = 0$), and free at the other end ($d^2w/dx^2 = 0$ and $d^3w/dx^3 = 0$). The full line represents the exact solution, and the dotted points the analogue solution. It is seen that the two solutions agree closely. There is a slight difference in the value of the vibration frequency, the analogue solution giving $\nu = 72.5$, whereas the exact solution is 71.8. The larger part (0.6 per cent) of this difference of 1 per cent is due to the truncation error, caused by the substitution in the network analogue of the fourth difference for the fourth-order derivative.

The network analogue method has also been applied to the problem of 'whirling shafts', where equation (1) is replaced by:

$$\frac{d^2}{dx^2} \left(EI \frac{d^2 w}{dx^2} \right) = 4\pi^2 m \nu^2 w \quad (4)$$

the main difference being that the moment of inertia I and the mass per unit length m are, in a practical problem, both functions of x . Hence, multiplying factors proportional to $m(x)$, which may be different for each network analogue point, have to be used

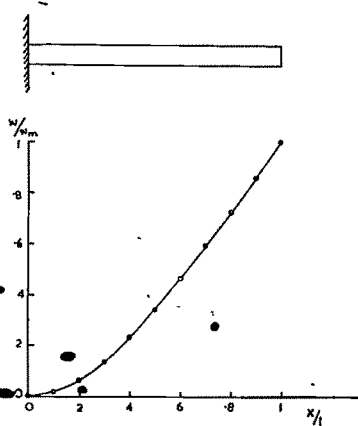


Fig. 1. Vibrating steel bar, 1 in. diameter and 50 in. long. ν exact = 71.8, ν exp. = 72.5. The continuous curve is theoretical; the points on the curve represent measurements made on the resistance network

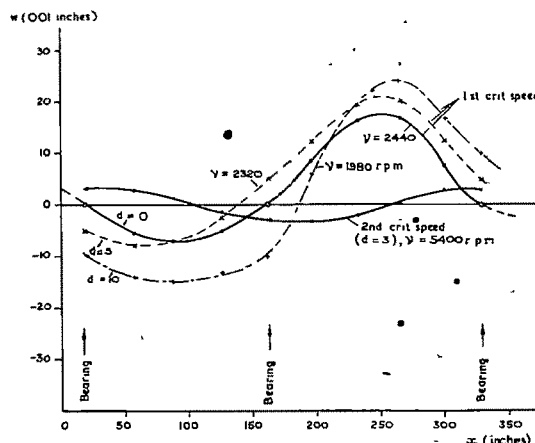


Fig. 2. Whirling shaft

when evaluating the currents to be fed in. Also, the resistances interconnecting the two networks may have different values, as each of these resistances is to be proportional to the value of EI averaged over the corresponding mesh interval. It is also possible to account for prescribed bearing deflexions by pre-setting the corresponding network voltages at the mesh points representing the bearings. Higher modes of the critical speed can be investigated by introducing additional vibration nodes ($w = 0$) and finding the positions of the additional vibration nodes which equalize the sectional values of ν . Fig. 2 shows a typical set of network analogue solutions for a 'whirling shaft', with uneven mass distribution and three bearings, for several values of bearing deflexion d (in 0.001 in.).

G. LIEBMANN

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston, Berks.
Jan 11.

¹ Liebmman, G., *Nature*, 172, 78 (1953).

² Liebmman, G., *Nature*, 164, 149 (1949).

³ Liebmman, G., *Proc. Inst. Elect. Eng.*, 99, Pt. IV, 260 (1952).

D-Layer Ionospheric Echoes at Macquarie Island

MANY ionosphere investigators have reported¹ echoes observed, presumably at vertical incidence, from an equivalent height of approximately 50 km. Ellyett¹ has described echoes observed from D -heights at some Pacific Islands, and considers that these particular echoes may be characteristic of a tropical region. Beagley² has observed similar echoes at Christchurch (lat. 43.5° S., long. 172.8° E.). Echoes from D -heights have been recorded at the Australian National Antarctic Research Expeditions' Station at Macquarie Island (lat. 54° 30' S., long. 158° 57' E.; geomag. lat. -61.7°) since the ionospheric recording apparatus began operation June 1950.

The Macquarie Island echoes, at a minimum virtual height of about 40 km., are identified as being of the same type as those observed at Pitcairn, Christmas and Raoul Islands and at Christchurch, thus rendering untenable the tropical phenomenon hypothesis. Macquarie Island echoes, of a strength comparable with those from the normal regions, are

observed on most days of the year, usually appearing within an hour after ground sunrise and disappearing during the hour before sunset. On a few occasions each month echoes persist throughout the night. The maximum frequency at which echoes are received usually increases from less than 2 Mc./s. at first appearance to greater than 7.5 Mc./s. at noon and falling to less than 2 Mc./s. at disappearance. Strong *D*-echoes remain on occasions when, due to high absorption, no echoes are received from the normal daytime-occurring ionospheric regions.

As the only factor common to the five stations under discussion is that four are islands and the fifth is sited on a headland with sea on both sides, it appears possible that the effect may be peculiar to island observatories.

G. MAJOR

Antarctic Division,
Department of External Affairs,
Melbourne.
Dec. 29.

¹ Ellyett, C. D., *Terr. Mag.*, 52, 1 (1947).

² Beagley, J. W., *N.Z. J. Sci. and Tech.*, B, 35 (1953).

Meaning of Turnover in Biochemistry

In a recent communication, Kleiber¹ criticized the 'logic' of the term 'turnover-rate' used as an index of rate of synthesis, exchange, or appearance of some material². He suggested that turnover-rate should properly refer only to the reciprocal of turnover time, that is, the fraction of a given metabolic pool renewed per unit of time.

Hevesy was among the first to investigate the quantitative aspects of isotope kinetics. He employed the term turnover-rate to denote the amount of material transferred per unit of time³. Many others have followed this usage⁴⁻⁶. An investigator may measure the rate of a metabolic process in terms of the fraction of the total metabolic pool renewed per hour; but it would be less confusing to designate this quantity by a term other than 'turnover-rate'. Kleiber¹ assumes that the use of 'turnover' in metabolic work arises from the analogy with the turnover of a wheel. However, this assumption may be unwarranted, for the early workers in the isotope field may have employed the analogy with the rapid turnover of patients in a well-organized hospital or the labour turnover-rate of an organization. This quantity may be expressed in terms of absolute turnover-rate (that is, the number of men entering or leaving the group), or as relative turnover-rate (the ratio of the absolute turnover-rate to the average working-force). Thus, there seems to be no *a priori* reason why the use of 'turnover-rate' should be restricted to the latter sense when dealing with metabolic processes. In our own work we have differentiated between (absolute) turnover-rates and fractional turnover-rates⁷. Reiner⁸ has used relative turnover-rate for the latter. Considerable confusion may be anticipated if various investigators attach different definitions to standard terms.

In recognition of the importance of a clear-cut terminology in this field, and in keeping with present-day usage, I wish to propose the following definitions:

Turnover-rate. The quantity of material turned over per unit of time.

Fractional turnover-rate. The fraction of a given pool turned over per unit of time.

Turnover-time. The time required for the turnover of an amount of material equal to the pool size; this is the reciprocal of the fractional turnover-rate.

D. B. ZILVERSMIT

Department of Physiology,
University of Tennessee,
Memphis 3, Tennessee.

March 19.

¹ Kleiber, M., *Nature*, 175, 342 (1955).

² Zilvermit, D. B., Entenman, C., and Fishler, M. C., *J. Gen. Physiol.*, 26, 325 (1943).

³ Hevesy, G., "Radioactive Indicators", 251 (Interscience Publishers, New York, 1948).

⁴ Kamen, M. D., "Radioactive Tracers in Biology", 135 (Acad. Press, New York, 1951).

⁵ Sacks, J., "Isotopic Tracers in Biochemistry and Physiology", 78 (McGraw-Hill, New York, 1953).

⁶ Reiner, J. M., *Arch. Biochem. and Biophys.*, 46, 53 (1953).

⁷ Di Luzio, N. R., and Zilvermit, D. B., *Amer. J. Physiol.*, 170, 472 (1952).

Paper Chromatography of Inositol Phosphates

In the course of an examination of the organic phosphorus compounds in soils, a fraction was isolated rich in a substance resembling phytic acid, and which on hydrolysis yielded meso-inositol. Since lower phosphate esters of inositol may be present in soil, a chromatographic study has been carried out on the products obtained on partial hydrolysis of authentic phytin by acid, or by an enzyme method described by S. and T. Posternak¹.

Of the many solvent systems investigated, the best had the composition: 70 vols. methanol/30 vols. 0.5 *N* ammonium hydroxide. The hydrolysate was best applied in a small band to the paper, which had previously been washed thoroughly with dilute hydrochloric acid, water, ammonium versenate and water, in that order. Upward development was carried out at about 23° C., but the temperature was not rigidly controlled. Spots were detected by spraying with the molybdate-perchloric acid reagent of Hanes and Isherwood², and heating the papers between glass plates in an oven at 90° C. for 30 min.

Four spots were obtained from the hydrolysates, with the following *R_F* values:

	<i>R_F</i>
(1) Inositol hexaphosphate	0.06
(2) First intermediate ester(s)	0.17
(3) Second intermediate ester(s)	0.32
(4) Orthophosphate + probable third intermediate	0.48

Resolution between the lowest two spots was not always absolute, depending upon the relative amounts of the two constituents present, but a clear demarcation could always be drawn between them. The spot with *R_F* value 0.17 is most likely to be the tetraphosphate, but work is being continued to establish the identity of the intermediates. There is evidence of a third intermediate, masked by the orthophosphate, and present in only very small amount even at advanced stages of hydrolysis.

Several inositol phosphates have been isolated by large-scale fractionation of phytic acid hydrolysates^{3,4}; but no paper chromatographic method of separation appears to have been published. The

method is clearly a useful approach to a study of the phytin fraction in soils, particularly where extremely small quantities are present.

A complete account of this work and the application of the method in qualitative and quantitative studies of the mositol phosphates present in soils will be published elsewhere.

G. ANDERSON

Department of Soil Fertility,
Macaulay Institute for Soil Research,
Craigiebuckler, Aberdeen.

Jan. 22.

¹Posternak, S., and Posternak, T., *Helv. Chim. Acta*, 12, 1165 (1929).

²Hanes, C. S., and Isherwood, F. A., *Nature*, 164, 1107 (1949).

³Anderson, R. J., *J. Biol. Chem.*, 20, 477 (1915).

⁴Courtois, J., *Bull. Soc. Chim. Biol.*, 33, 1075 (1951).

Earthworm Population Studies : a Comparison of Sampling Methods

IN 1947, Evans and Guild¹ described a new technique for the quantitative extraction of earthworms. This consisted of treating a known area with a solution of potassium permanganate (1.5 gm. per litre) at the rate of 6.8 litres per sq. metre. The method was said to recover a high proportion of the total population and has, since the initial description, been extensively used by these authors².

I found, however, that population estimates obtained by the permanganate technique were considerably lower than those suggested when a more laborious hand-sorting method was employed. In order to measure the relative efficacy of these techniques, permanent pasture on light soil of alluvial origin was sampled by both methods contiguously. The tests were made during September 1954, at the Durham County Council School of Agriculture, Houghall Farm.

Permanganate sampling was carried out according to Evans and Guild¹, except that the sample area was increased from 7.29 sq. ft. to 1 sq. metre. Soil samples for hand-sorting were extracted by means of a steel scoop of semicircular cross-section. This cut a core 283 sq. cm. in area and 20 cm. deep, thus needing thirty-five to complete a square metre. In each of ten loci chosen at random over the site, a permanganate sample was taken; and in every case the treatment was repeated after an interval of two hours. Five soil cores were removed from the adjacent but unaffected area of each permanganate sample.

The results are shown in Table 1 as the average number of worms per locus and sq. metre. These

Table 1. AVERAGE NUMBER OF WORMS PER LOCUS AND SQUARE METRE

Species	First permanganate treatment. Av. No. per locus and sq. m.	Second permanganate treatment. Av. No. per locus and sq. m.	Soil cores	
			Av. No. per locus	Av. No. per sq. m.
<i>Lumbricus terrestris</i>	5.0 ± 2.8	9.1 ± 4.7	9.3 ± 1.3	65.1
<i>Lumbricus castaneus</i>	3.2 ± 2.1	2.8 ± 2.2	7.8 ± 2.9	54.6
<i>Octolasion cyaneum</i>	0.2 ± 0.6	0.5 ± 0.7	1.5 ± 1.2	10.5
<i>Allolobophora terrestris</i>	19.8 ± 4.6	8.3 ± 3.4	21.4 ± 5.0	149.8
<i>Allolobophora caliginosa</i>	5.2 ± 2.4	9.0 ± 2.6	11.1 ± 3.9	77.7
<i>Eisenia rosea</i>	1.6 ± 1.0	3.7 ± 3.4	12.8 ± 5.6	89.9
Total	35.0 ± 10.2	29.4 ± 9.8	83.9 ± 9.8	447.6

Table 2. ANALYSIS OF VARIANCE. SNEDECOR'S F

Species	Soil cores First permanganate treatment		Soil cores First and second permanganate treatments	
	Between treatments d.f. 1:9	Between samples d.f. 9:9	Between treatments d.f. 1:9	Between samples d.f. 9:9
<i>Lumbricus terrestris</i>	0.00	0.74	11.28†	0.99
<i>Lumbricus castaneus</i>	4.35	2.41	2.35	2.08
<i>Octolasion cyaneum</i>	2.86	0.90	4.20	3.06
<i>Allolobophora terrestris</i>	53.81†	1.46	16.33†	1.87
<i>Allolobophora caliginosa</i>	2.48	2.41	0.69	2.82
<i>Eisenia rosea</i>	61.66†	1.61	52.72†	4.41*

* Significant at the 5 per cent level. † Significant at the 1 per cent level

units are the same for the permanganate treatments but not for the soil cores, where the number per locus must be multiplied by 7 to estimate the number per sq. metre.

While the fifty soil cores, completing 1.43 sq. metres, produced 639.5 worms, the permanganate samples of 10 sq. metres produced only 350 worms. Thus it is abundantly clear that the permanganate technique gave an unsatisfactorily low population estimate, although of the same order as those of Evans and Guild^{1,2}.

To determine whether or not the techniques extracted similar species ratios, analyses of variance were calculated for treatment-pairs. The percentage of species per locus was used for this purpose and the results, as Snedecor's *F*³, are given in Table 2.

In no case is there significant variance, at the 1 per cent level, between samples, which suggests an even distribution of the earthworm population and an intrinsic consistency of sampling method. Although all the techniques are consistent by themselves, they differ when compared with each other; and in three species significant variance occurs between treatments. Thus relative to the proportion from the soil cores, the first permanganate treatment produced more specimens of *Allolobophora terrestris* and fewer *Eisenia rosea* than expected. Conversely, the second permanganate treatment produced more specimens of *Lumbricus terrestris* and fewer *Eisenia rosea*. This correlation of effect with species is interesting in suggesting that potassium permanganate, in conjunction with a hand-sorting method, may be useful in determining the habits of different species.

The evidence discussed above shows that the permanganate method of sampling, used alone, is unsuitable for comparative population studies of earthworms.

I am indebted to Dr. B. M. Church, of Rothamsted, and Dr. E. S. Page, of the Durham Colleges, for their advice in the use of analyses of variance. The work was carried out while receiving a grant from the Nature Conservancy.

J. A. SVENDSEN

Zoology Department,
Durham Colleges,
University of Durham.
Jan. 15.

¹ Evans, A. C., and Guild, W. J. McL., *Ann. App. Biol.*, 34, 307 (1947).

² Guild, W. J. McL., *Ann. App. Biol.*, 35, 181 (1948). Evans, A. C., and Guild, W. J. McL., *Ann. App. Biol.*, 35, 471 and 485 (1948).

³ Snedecor, G. W., *Statistical Methods* (Iowa State College Press, 1946).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, May 16

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. G. B. Brown: "Unification of Macroscopic Physics by Action-at-a-Distance".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. S. Romer (Harvard): "Texas Redbed Fossils and Vertebrate Evolution".*

UNIVERSITY OF LONDON (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. D. J. Cram (University of California): "Certain Problems in Large Ring Chemistry".*

Tuesday, May 17

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Sir R. E. Mortimer Wheeler: "Aspects of the Ascent of a Civilization" (Hobhouse Memorial Lecture).

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London W.2), at 5 p.m.—Dr. A. T. R. Mattick: "The Lactobacilli and some Streptococci" (Almroth Wright Lecture).

Tuesday, May 17—Friday, May 20

TEXTILE INSTITUTE (at Caxton Hall, Caxton Street, London, S.W.1)—40th Annual Conference—"Practice and Progress in the Textile Industry".

Tuesday, May 17—Saturday, May 21

INSTITUTE OF METAL FINISHING (at the Palace Hotel, Torquay)—Annual Conference.

Wednesday, May 18

CHEMICAL SOCIETY (in the Department of Chemistry, The University, Leeds), at 10 a.m.—Symposium on "The Friedel-Crafts Reaction".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London W.C.2), at 2.30 p.m.—Sir Alexander Todd, F.R.S.: "Some Recent Developments in the Chemistry of Nucleic Acids" (Pope Memorial Lecture).

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 3 p.m.—Miss K. Slack: "The Community's Responsibility for Special Groups—The Disabled and Old People". (Third of seven University Extension Lectures on "The Development and Pattern of the Social Services".)

PHYSICAL SOCIETY, COLOUR GROUP (in the Large Physics Theatre, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3.30 p.m.—Address by Dr. D. B. Judd (National Bureau of Standards, Washington, D.C.): 5.30 p.m.—Dr. D. L. MacAdam (Eastman Kodak Company, U.S.A.): "Colour and Its Measurement".*

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. E. T. Pierce: (a) "Electrostatic Field-Changes due to Lightning Discharges"; (b) "The Development of Lightning Discharges"; Mr. R. F. Jones: "Radar Echoes from Lightning".*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mr. A. J. Cruise: "Morphological Variants in Mammalian Connective Tissue Fibres".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. D. R. Coleman, Mr. D. A. Allanson and Mr. B. A. Hoglock: "The Development of the Underwater Television Camera".

Thursday, May 19

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 4 p.m.—Dr. C. M. Fletcher: "Atmospheric Pollution and Disease".*

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Prof. Sir Alfred Egerton, F.R.S.: "Scientific Research in India" (Thomas Holland Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Annual General Meeting. 6.30 p.m.—The Rt. Hon. Lord Ciriene, P.C.: "Human Relations in Industry".

ROYAL AERONAUTICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. C. S. Draper: "Flight Control" (43rd Wilbur Wright Memorial Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. A. Corradetti: "Studies on Comparative Pathology and Immunology in Mammal and Bird *Plasmodium* Infections".

BRITISH INSTITUTE OF RADIOLOGY incorporated with the RÖNTGEN SOCIETY (at 32 Welbeck Street, London, W.1), at 8 p.m.—Annual General Meeting. 8.30 p.m.—Mr. J. A. C. Fleming: "Some Reflections on the Position and Scientific Role of the Institute" (Presidential Address).

Friday, May 20

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. H. C. Pritchard: "Automatic Dead Reckoning Instruments".

UNIVERSITY OF LONDON (at St. Thomas's Hospital Medical School, London, S.E.1), at 5 p.m.—Prof. V. Brsparer (Bart): "The Biological Significance of 5-hydroxytryptamine and Related Substances".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Sir Wilfrid Le Gros Clark, F.R.S.: "The Exposure of the Piltdown Forgery".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER (with a degree in agriculture or equivalent qualification, sound experience in practical work, and preferably experience in teaching in AGRICULTURE, at the Cumberland and Westmorland Farm School, Newton Riggs, near Penrith—The Director of Education, 5 Portland Square, Carlisle (May 18).

LECTURER (with a good honours degree in physics, and preferably able to teach the subject to a high standard) IN PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan (May 19).

ASSISTANT CHEMIST (Fuel) (with H.N.C. in chemistry or equivalent, and experience associated with the sampling and analysis of fuel and related work) IN THE DIVISIONAL CHEMICAL LABORATORY, Leeds—The Divisional Secretary (Establishments), Central Electricity Authority, Yorkshire Division, Central Electricity House, St. Mary's Road, Leeds 7 (May 21).

ASSISTANT LECTURER (with special interests in the field of cartography) IN GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (May 21).

RESEARCH MICROBIOLOGIST (Scientific Officer grade) IN THE DOMESTIC FOOD PRESERVATION SECTION at the Long Ashton Research Station, Bristol—The Registrar and Secretary, The University, Bristol (May 21).

SENIOR LABORATORY TECHNICIAN, to be responsible for the physics laboratories and stores—The Secretary, Paddington Technical College, Saltram Crescent, London, W.9 (May 21).

ASSISTANT LECTURER IN BIOLOGY, ASSISTANT LECTURER IN BIOCHEMISTRY, and a SENIOR LECTURER or LECTURER IN THE DEPARTMENT OF VETERINARY PHYSIOLOGY—The Secretary, Royal Veterinary College, Royal College Street, London, N.W.1 (May 25).

UNIVERSITY LECTURER (with an appropriate honours degree and with experience of research and teaching) IN AGRICULTURAL MYCOLOGY—The Secretary, School of Agriculture, Downing Street, Cambridge (May 25).

ASSISTANT IN THE DEPARTMENT OF GEOGRAPHY—The Secretary, The University, Edinburgh (May 28).

LECTURER IN SOCIOLOGY in the Department of Social Anthropology—The Registrar, The University, Manchester 13 (May 28).

LECTURER IN THE FLUID MOTION LABORATORY, to work on problems of electronics and instrumentation for the measurement and observation of fluid flow, including turbulence, the propagation of shock waves and aerodynamic noise—The Registrar, The University, Manchester 13 (May 28).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BOTANY—The Registrar and Secretary, The University, Bristol 8 (May 28).

SENIOR LECTURER IN SOCIAL PSYCHOLOGY—The Secretary of University Court, The University, Glasgow (May 28).

ASSISTANTS IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Edinburgh (May 30).

STATISTICIAN (with a good honours degree or postgraduate diploma in statistics, or a good honours degree in mathematics with postgraduate experience in statistics) IN THE AGRICULTURAL RESEARCH COUNCIL'S UNIT OF STATISTICS attached to the Department of Statistics, University of Aberdeen—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (May 31).

PHYSICIST (with a good knowledge of classical physics and ability in application to process problems and machine design), for advanced research on mechanical and hydraulic systems for briquette manufacture now approaching the development stage—The National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting TT/966 (June 1).

PROFESSOR OF MATHEMATICS, and a PROFESSOR OF CHEMISTRY—Dr. W. A. Jenkins, Vice-Chancellor, University of Dacca, c/o the Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 1).

RESEARCH ASSISTANT IN THE DEPARTMENT OF APPLIED MATHEMATICS for theoretical work on upper atmosphere physics—Prof. D. R. Bates, F.R.S., Department of Applied Mathematics, Queen's University, Belfast (June 1).

ASSISTANT LECTURER IN PSYCHOLOGY—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (June 3).

ASSISTANT LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (June 4).

LECTURERS or ASSISTANT LECTURERS (3) IN PHYSICS—The Registrar, The University, Leeds 2 (June 4).

RESEARCH DEMONSTRATOR IN PHYSICS—The Registrar, The University, Sheffield (June 4).

SCIENTIST, Grade II (with a good honours degree or equivalent with the main qualification in chemistry, and preferably with experience in the analysis of solid fuels), on the staff of the Director of Scientific Control at London Headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/975 (June 4).

LECTURER IN PHILOSOPHY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 6).

ENDO-PARASITOLOGIST (with a university degree in science with zoology to an advanced stage and preferably with experience in the investigation of parasitology), at the Animal Research Station, Wallaceville, New Zealand.—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting 3/4/42 (June 7).

CHAIR OF BOTANY at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 10).

PROFESSOR OF BOTANY at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Ceylon, June 15).

LECTURER, Grade II (with special interests in the philosophy of science, and preferably with a qualification in a natural science), in **PHILOSOPHY**—The Registrar and Secretary, The University, Bristol (June 18).

RESEARCH ASSISTANT TO THE PROFESSOR OF FUEL TECHNOLOGY—The Registrar, The University, Sheffield (June 18).

RESEARCH FELLOW (preferably with experience in low energy nuclear physics, or photo disintegration problems) in the **DEPARTMENT OF NUCLEAR PHYSICS**, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 30).

SCIENTIFIC OFFICER (with a good honours degree in botany or agricultural botany and preferably with an interest in fruit culture and plant physiology), for work on the growth and development of soft fruits, mainly the raspberry; and an **EXPERIMENTAL OFFICER** (with a degree in horticulture or general biology, preferably with some training in genetics) to assist in soft fruit breeding—The Secretary, Scottish Horticultural Research Institute, Mylnesfield, Invergowrie, Dundee (June 30).

AGRICULTURAL OFFICER (with a university degree in agriculture or a related subject, and a sound knowledge of field experimentation with particular reference to techniques for grassland research, feeding trials and nutritional studies), at St. Ignatius Livestock Station, British Guiana, to undertake investigational and field work on pasture and fodder grasses and other crops suitable for the area—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/30/03.

ANALYTICAL CHEMIST, Experimental Officer grade (preferably with a pass degree in chemistry, or at least H.S.C. (science) or equivalent), for research and development work in an analytical laboratory—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 629/WGE/34.

ASSISTANT LECTURER IN DAIRYING at the School of Agriculture, Sutton Bonington, near Loughborough—The Registrar, The University, Nottingham.

EXPERIMENTAL OFFICERS (preferably with a pass degree or at least H.S.C. (science) or equivalent), and **ASSISTANT EXPERIMENTAL OFFICERS** (with at least H.S.C. (science) or equivalent), for the design and application of pneumatic control systems mainly for the measurement of temperature and humidity—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 627/WGE/34.

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent qualification in electrical or mechanical engineering or physics), at the Ministry of Supply London Headquarters, to lead a section responsible for initiating and supervising research and development in design of aircraft flight instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.274/5A.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in mathematics, physics or economics), for operational research in or near London—under the direction of the Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 384/54.

Carnegie United Kingdom Trust. Forty-First Annual Report, 1954. Pp. vii+43. (Dunfermline: Carnegie United Kingdom Trust, 1955.) [93]

Iron and Steel Institute. Special Report No. 51: A Survey of the Results of the Examination of the Brickwork of Blown-Out Blast-Furnaces. Pp. iv+35. (London: Iron and Steel Institute, 1954.) 25s. [93]

Proceedings of the Royal Irish Academy. Vol. 56, Section A, No. 6: A General Variational Principle for Dissipative Systems—2. By J. W. Herivel. Pp. 67-76. 1s. 6d. Vol. 57, Section A, No. 1: High-Order Focusing by a Uniform Magnetic Field with Straight-Line Boundaries. By E. T. S. Walton. Pp. 14. 2s. Vol. 57, Section A, No. 2: The Spectrum of MnCl and MnBr in the Near Ultraviolet. By W. Hayes and T. E. Nevin. Pp. 15-30. 2s. 6d. Vol. 57, Section B, No. 1: The Distribution of Certain Interstitial Animals Around the Irish Coast. By A. J. Southward and D. J. Crisp. Pp. 30. 4s. Vol. 57, Section B, No. 2: The Constitution of Arabic Acid—Part 2. By Thomas Dillon, Donnachadh F. O'Ceallaigh and Proinsias O'Colla. Pp. 31-38. 1s. Vol. 57, Section B, No. 3: Antitubercular Substances—12: Long-Chain Aliphatic Derivatives of Nitrogenous Compounds. By Dermot Twomey. Pp. 39-46. 1s. Vol. 57, Section B, No. 4: Antitubercular Substances—13: New Polymeric Agents Derived from Oxyolysaccharides. By Vincent C. Barry, Joan E. McCormick and P. W. D. Mitchell. Pp. 47-54. 1s. (Dublin: Hodges, Figgis and Co., Ltd., 1954 and 1955.) [93]

Other Countries

Bulletin of the Astronomical Institute of the Netherlands. Vol. 12, No. 459 (February 12, 1955): The Pulsations of AI Velorum, SX Phoenixis and RR Lyræ. By Th. Walraven. Pp. 223-266. Vol. 12, No. 460 (February 14, 1955): Photographic Positions of Minor Planets and of Comet 1953a, Observed in 1952 and 1953. By G. Pels. Pp. 267-272. (Liden: Astronomical Institutes of the Netherlands, 1955.) [93]

Canada. Ministère du Nord Canadien et des Ressources Nationales: Division des Parcs Nationaux. Musée National du Canada. Description de la Culture de l'Île Verte. Par Marcel Rioux. (Bulletin No. 138. No. 35 de la Série Anthropologique.) Pp. ii+98. (Ottawa: Queen's Printer, 1954.) 1 dollar. [93]

National Research Council of Canada. 1953-1954 Supplement to the List of Publications of the National Research Council of Canada. Third edition. (N.R.C. 3000-A.) Pp. 40. (Ottawa: National Research Council of Canada, 1955.) [93]

Canada. Department of Northern Affairs and National Resources. National Parks Branch. National Museum of Canada. The Vanta Kutehin. By Douglas Leechman. (Bulletin No. 130—Anthropological Series No. 33.) Pp. iii+35 (6 plates). (Ottawa: Queen's Printer, 1954.) 1 dollar. [93]

Chittaranjan Cancer Hospital, Calcutta. Years of Progress, 1950-1953. Pp. 42. (Calcutta: Chittaranjan Cancer Hospital, 1954.) [93]

West African Institute for Oil Palm Research. Quarterly Progress Report No. 11: October 1st 1954 to December 31st 1954. Pp. 19. (Benin City: West African Institute for Oil Palm Research, 1955.) [93]

Strömung durch Rohre; Umströmung von Körpern bei Zweidimensionaler Strömung; Umströmung von Körpern bei Räumlicher Strömung. Von L. Schiller. (Sonderabdruck aus "Landolt-Börnstein": Zahlenwerte und Funktionen aus Physik, Chemie, Astronomie, Geophysik und Technik.) Pp. 682-796. (Berlin: Springer-Verlag, 1955.) [93]

Sudan Government. Sudan Museum (Natural History). Publication No. 4: Catalogue of Wild Mammals of the Sudan, occurring in the natural orders Artiodactyla and Perissodactyla. By P. Z. Mackenzie. Pp. 21+1 map. (Khartoum: Natural History Museum, 1954.) 40 piastres. [93]

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien. Band 5, Nr. 4: Die Diatomeen von Schweden und Finnland. Von Astrid Cleve-Euler. (Teil 4: Biraphideae—2.) Pp. 232+50 plates. 62 kronor. Band 5, Nr. 5: The Photoelectric Instrument at the Kvistaberg Observatory. By Åke Wallenquist. Pp. 20. 3.75 kronor. (Stockholm: Almqvist and Wiksells Boktryckeri AB; London: H. K. Lewis and Co., Ltd., 1955.) [93]

Connecticut Agricultural Experiment Station. Bulletin 564: Growing Tobacco in Connecticut. By P. J. Anderson. Pp. 110. Bulletin No. 565: Boxwood Pests and Their Control. By John C. Schread. Pp. 12. Bulletin No. 566: The Formation and Development of the Norway Spruce Gall Caused by *Adelges abietis* L. By George H. Plumb. Pp. 77 (16 plates). Bulletin No. 567: A Study of Spray Machines in Connecticut Orchards. By Philip Garman. Pp. 34. Bulletin No. 568: Control of the Andromeda Lace Bug and the Holly Leaf Miner. By John C. Schread. Pp. 13. Bulletin No. 569: Chemical Investigations of the Tobacco Plant. 9: The Effect of Curing and of Fermentation on the Composition of the Leaves. By Hubert Bradford Vickery and Alfred N. Meiss. Pp. 125. Bulletin No. 570: Methyleneoxyphenyl Synergists for Insecticides. By Neely Turner. Pp. 22. Bulletin No. 571: Report on Commercial Insecticides and Fungicides, 1953. By H. J. Fisher. Pp. 21. Bulletin No. 572: Tests of a Light-Weight Mist Blower. By S. F. Potts, R. A. Spencer and R. B. Friend. Pp. 10. Bulletin No. 573: Report on Inspection, Commercial Feedings Stuffs, 1952. By H. J. Fisher. Pp. 116. Bulletin No. 574: The 56th Report on Food Products, and the 44th Report on Drug Products, 1951. By H. J. Fisher. Pp. 79. Bulletin No. 575: Control of Peach Insects. By Philip Garman, W. T. Brigham and A. DeCaprio. Pp. 64. Bulletin No. 576: Quality of Apples as Affected by Sprays. By Philip Garman, L. G. Keirstead and W. T. Mathis. Pp. 46. Bulletin No. 577: Static and Dynamic Variation in the Response of an Insect to Substantial Doses of Two Gases. By C. I. Bliss and R. L. Beard. Pp. 24. Circular No. 184: Control of the Japanese Beetle and the Asiatic Garden Beetle. By John C. Schread. Pp. 10. (New Haven, Conn.: Connecticut Agricultural Experiment Station, 1953.) [153]

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures, and Condition of the Institution for the year ended June 30. (Publication 4149.) Pp. ix+481+83 plates. (Washington, D.C.: Government Printing Office, 1954.) 3.75 dollars. [163]

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Agricultural Research Council. Training Grants, Studentships and Fellowships offered in 1955. Pp. 15. (London: Agricultural Research Council, 1955.) [23]

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 655, Vol. 238 (31 December 1954): Sensitivity to Light and the Reactions to Changes in Light Intensity of the Echinoid *Diadema Antillarum* Philippi. By N. Millott. Pp. 187-220+plates 15 and 16. No. 658, Vol. 238 (1 March 1955): The Fauna of the Derfel Limestone of the Arenig District, North Wales. By H. B. Whittington and A. Williams. Pp. 397-430+plates 38-40. 16s. No. 659, Vol. 239 (1 March 1955): The Feeding Mechanism of the Butterfly *Pieris Brassicae* L. By L. E. S. Eastham and Y. E. E. Rassa. Pp. 43. 13s. 6d. (London: Royal Society, 1954 and 1955.) [23]

Abstracts of Dissertations approved for the Ph.D., M.Sc., and M.Litt. Degrees in the University of Cambridge during the Academic Year 1952-1953. Pp. xviii+272. (Cambridge: The University, 1955.) [93]

Chelsea Polytechnic. Fifty-Ninth Annual Report—Session 1953-54. Pp. 30. (London: Chelsea Polytechnic, 1955.) [93]

Occasional Papers on Eugenics. No. 9: Some Aspects of World Population and Food Resources. By Lord Simon of Wythenshawe. Pp. 19. (London: Eugenics Society and Cassell and Co., Ltd., 1955.) 2s. 6d. net. [93]

Ministry of Food. Food Standards Committee Report on Arsenic: Revised Recommendations for Limits for Arsenic in Foods. Pp. 5. (London: H.M. Stationery Office, 1955.) 4d. net. [93]

West of Scotland Agricultural College. Bulletin No. 152: A Grazing Trial Comparing Aberystwyth and Commercial Strains of Grasses. By I. V. Hunt and J. M. Thomson. Pp. 30. (Glasgow: West of Scotland Agricultural College, 1955.) 1s. [93]

NATURE

No. 4464

SATURDAY, MAY 21, 1955

Vol. 175

CONTENTS

	Page
Leadership in the Coal Industry of Britain	867
Etiology of Anti-Semitism. By Prof. C. A. Mace	870
Landscape of Britain. By Dr. L. Harrison Matthews, F.R.S.	871
The Pathology of Co-operation in Industry. By E. F. L. Brech	872
Radiological Hazards from Nuclear Explosions and Nuclear Power. By Sir John Cockcroft, K.C.B., C.B.E., F.R.S.	873
Biochemistry of Vitamin B ₁₂	875
Research Investigations of the Central Electricity Authority. By Dr. J. S. Forrest	877
Obituaries:	
Prof. D. T. Barry. By Prof. Joseph Reilly	879
Prof. Gwyn Williams	880
News and Views	880
Soilless Cultivation of Crops in India. By J. W. E. H. Sholto Douglas	884
Electronics in the Imperial College of Science and Technology, London. By Dr. D. Gabor	885
X-Ray Analysis Group of the Institute of Physics: Spring Conference. By Dr. U. W. Arndt	886
South-Eastern Union of Scientific Societies: Annual Congress	888
Carnegie United Kingdom Trust: Report for 1954	889
Radiation Sensitivity and the Mitotic Cycle in <i>Vicia faba</i> . By Dr. John McLeish	890
Letters to the Editors:	
Rock Magnetism in Iceland.—Prof. Trausti Einarsson and Thorbjörn Sigurgeirsson	892
Geophysical Work in North Greenland.—R. J. M. Bruce and C. Bull	892
Electrons in Solutions.—Joshua Jortner and Dr. Gabriel Stein	893
The Hydrogen Atoms in Alpha-Resorcinol.—Dr. G. E. Bacon and N. A. Curry	894
Detection of Free Radicals in Polyacrylonitrile by Paramagnetic Resonance.—Dr. C. H. Bamford, Dr. A. D. Jenkins, Dr. D. J. E. Ingram and Dr. M. C. R. Symons	894
Melting Behaviour of Crystalline Polymer Fibres.—Dr. T. R. White	895
An Easily Assembled Continuous Electrophoresis Apparatus.—H. A. Saroff	896
A Simple Paper Chromatographic Technique for the Study of Free Metabolites of Tissues and Body Fluids.—Dr. Giovanni Ceriotti	897
Chromatography of Serum and some other Proteins on an Anion-exchange Resin.—Dr. Hans G. Boman	898
Inhibition of Induced Enzyme Formation by Purine Analogues.—E. H. Creaser	899
Bacterial Utilization of Cyanide.—Dr. G. C. Ware and Dr. H. A. Painter	900
Vaginal Sulphydryl and Disulphide Groups during the Oestrous Cycle of the Mouse.—A. W. Asscher and C. J. Turner	900
Experimental Evidence for an Enzymatic Basis for Itching in Man.—Dr. Robert P. Arthur and Dr. Walter B. Shelley	901
Amino-Acid Composition of Four Different Kinds of Human Hæmoglobin.—Dr. T. H. J. Huisman, Prof. J. H. P. Jonxis and P. C. van der Schaaf	902
Chromatographic Estimation of Different Kinds of Human Hæmoglobin.—H. K. Prins and Dr. T. H. J. Huisman	903
Nature of the Cuticle of Pycnogonida.—Dr. G. Krishnan	904
Meiosis in <i>Furcellaria fastigiata</i> (L.) Lamour.—A. P. Austin	905
Golgi Bodies in the Spermatogenesis of Pulmonate Gastropods.—Prof. Vishwa Nath	905
Failure of Myxomatosis on Skokholm Island.—R. M. Lockley	906
Effect of 'Tobacco Leaf-Curl' and Tobacco Mosaic Virus on the Amino-acid and Amide Content of <i>Nicotiana</i> sp.—M. M. Laloraya and Govind Jee	907
Extreme Resolution of Infra-Red Absorption Spectra.—Dr. J. H. Jaffe, Dr. T. A. Wiggins and Prof. D. H. Rank	908
A Solar Noise Outburst of January 15, 1955.—T. R. Hartz	908
Low-voltage, Short-duration Arcs between Separating Contacts in Low-voltage, substantially Non-inductive Circuits.—Mrs. Janet Riddlestone	909
The New British Museum Law.—Dr. Marie C. Stopes	910

Editorial and Publishing Offices of Nature

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number : Whitehall 8831. Telegrams : Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1

Telephone Number : Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

CHAPMAN & HALL

3 NEW JOHN WILEY BOOKS 3

MULTIPOLE FIELDS

by

M. E. ROSE

(Chief Physicist, Oak Ridge National Laboratory)

Size: $9\frac{1}{2}$ in. $\times$ 6 in.

107 pages

40s. net

ORGANIC SYNTHESSES

(Collective Volume III)

Edited by

E. C. HORNING

Size: $9\frac{1}{2}$ in. $\times$ 6 in.

890 pages

Illustrated

120s. net

SOIL FERTILITY

by

C. E. MILLAR

(Professor Emeritus of Soil Science, University of Michigan)

Size: $9\frac{1}{2}$ in. $\times$ 6 in.

447 pages

Illustrated

54s. net

(All to be published 25th May)

37 ESSEX STREET, LONDON, W.C.2

The SCIENTIFIC BOOK SUPPLY SERVICE
(T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

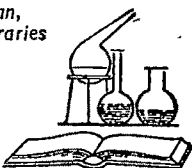
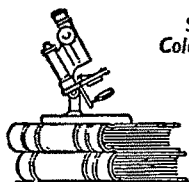
Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American,
Colonial & Foreign LibrariesSpecialists in
Scientific Books &
Periodicals

PHONE: CEN. 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4



LENDING LIBRARY

SCIENTIFIC, TECHNICAL, MEDICAL

Annual Subscription from 25s.

PROSPECTUS POST FREE ON REQUEST

THE LIBRARY CATALOGUE containing classified Index of Authors and Subjects, revised to December, 1949. Pp. xii + 1152. To subscribers 17s. 6d. net. To non-subscribers 35s. net; postage 1s. 3d. Supplement 1950 to 1952. To subscribers 3s. net; to non-subscribers 6s. net; postage 6d.

H. K. LEWIS & Co. Ltd.

136 GOWER STREET, LONDON, W.C.1

Telephone: EUSTON 4282 (7 lines)

Established 1844

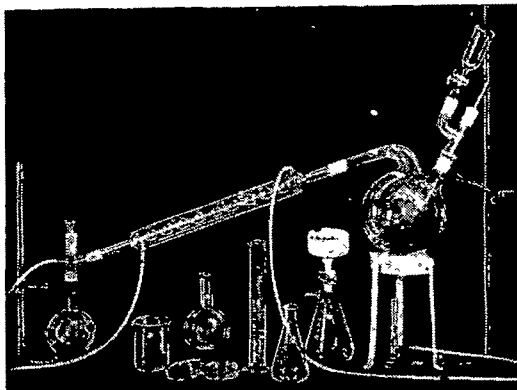
Glass apparatus to your specification

Your general Laboratory Glassware
and Requisites

THE SCIENTIFIC GLASSBLOWING CO. LTD.

95, GRAY'S INN ROAD, LONDON, W.C.1

Telephone: HOLBORN 4228



LEADERSHIP IN THE COAL INDUSTRY OF BRITAIN

THE report of the Advisory Committee, with Dr. A. Fleck as chairman, on the organization of the National Coal Board*, is a document of great interest to the scientist and technologist. In replying to a question in the House of Commons on the day of publication of the report, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, said that there was a certain broad connexion between the report and his statement of February 15 on the development of nuclear power, and that the report indicated that there was a "real need for a technical and managerial renaissance in the coal industry to fit it to take its part in the atomic age". Besides the bearing of the report on the technological efficiency of the coal industry in Britain and the ability of that industry to take full advantage of technological advance, the report is also of great interest in relation to the administration of nationalized industry in general, and to the question of centralization and decentralization in any large-scale enterprise.

These are all matters that interest the scientist and may affect him closely; but he is even more closely concerned with the observations of the report on recruitment and training for the highest managerial positions in such large concerns. That in turn is a matter which touches closely on education for management in general, the balance between the faculties of science and arts in the universities, between universities and the colleges of technology, and kindred matters which have been constantly discussed of late in connexion with the expansion of higher technological education in Britain. Since the report was published, moreover, the British Institute of Management has published a report and recommendations dealing specifically with the recruitment and training of men intended for management positions†, while some of the discussions at the International Conference on the Functions and Education of the Chemical Engineer organized by the European Productivity Agency in London during March 21-23, in co-operation with the Institution of Chemical Engineers (see *Nature*, May 14, p. 842), were concerned with the place of the chemical engineer in management and administration, and with what could be done to enable him to make his full contribution to industrial productivity.

The Fleck Committee consisted of no more than five members, and was appointed in December 1953, beginning its work forthwith. Not the least merit of the report is the concise but clear statement of the position and size of the industry presented in the introduction; this should facilitate a better public understanding of how much has been done since the Board was set up in 1946, and thus eliminate some of the ill-informed criticism from which the Board has suffered in the past. So, too, the brief review of

the needs and problems of large business undertakings, which precedes a note on the special problems of the nationalized coal industry, helps to supply a perspective for objective judgments and to correct the partisan approach which too often has darkened counsel.

The general criticisms made in this report do not necessarily apply to every department or to every part of the National Coal Board, although the weaknesses indicated are sufficiently widespread to warrant comment and to justify correction. The criticisms, moreover, do not detract from the considerable achievements for which the Board has been responsible in the face of difficulties to which the Fleck Committee can find no parallel in any other industry of which its members have knowledge. An organization for managing a thousand pits, previously run by eight hundred companies, was planned and brought into operation in a matter of months. The nine hundred collieries owned and operated by the Board in 1954 produced 212 million tons of coal. The financial turnover exceeds £700 million, and, besides 700,000 mine-workers, the Board employs 30,000 colliery under-officials and a further staff of 40,000. Not only is the industry widely dispersed, but also its secondary interests are varied, and some, notably the coking-plants, are vitally important.

The Fleck Committee puts the whole question of the National Coal Board and its organization fairly in the context of Great Britain's demand for fuel and power. The economic possibilities of nuclear energy are admittedly still uncertain, but ultimately are likely to change the pattern of our consumption of fuel and power. Meanwhile, however, for many years coal must continue to be the main source of supply, and a comparatively small amount of coal makes the difference between full-scale economic activity on one hand and a fuel crisis on the other. Much of the energy of the National Coal Board is concerned with this margin of output and with securing, that some element of flexibility is brought into the fuel situation of the country.

This is largely a matter of management, and while the Fleck Committee considers that the present large-scale review of the Board's organization is well timed, it is no less emphatic that it should be the last of its kind for some time. It recommends indeed an immediate reorganization of the National Coal Board, which it believes should consist of a chairman and a deputy chairman, six other full-time members and four part-time members, the appointments to be so arranged as to ensure continuity and, among the full-time members, a sound age distribution. It recommends that in reconstituting the Board the Minister should give special attention to the necessity of ensuring that the members are able to work together as a team and that in future, before appointing part-time members, he should seek the advice of a body of leaders in particular fields; while before appointing a chairman or a deputy chairman,

* National Coal Board. Report of the Advisory Committee on Organisation. Pp. iii+105 (London: National Coal Board, 1955.) 2s. 6d.

† British Institute of Management. The Recruitment and Training of Men intended for Management Positions. Pp. 70. (London: British Institute of Management, 1955.) 5s.

he should be advised by the part-time members. These recommendations were accepted forthwith by the Government; the further recommendation that the salaries of the chairman and the other full-time members should be substantially increased has yet to be implemented, though the Board has undertaken to carry out as soon as possible a review of salaries at divisional headquarters "to make sure that they attract the best men to responsible positions there". The recommendation, however, is vital and is clearly one which, as the Fleck Committee does not fail to observe, engages the responsibility of the Minister and cannot be implemented without the exercise of his powers. Because there is nothing in the legislation under which the National Coal Board operates that prevents the industry being managed in accordance with the best commercial practice, or hinders the pursuit of much the same financial policy as a large commercial undertaking, it is imperative that the Board should be able to offer conditions of service competitively attractive to the appropriate talent at all levels.

On all this the Fleck Committee is emphatic. It recognizes that the industry managed by the Board is a very large amalgamation of units varying greatly in size and in the efficiency with which they were being managed immediately before the amalgamation. Much the same problems, however, confront all boards placed in charge of large amalgamations. To secure uniformly good management for the various units, to see that facilities for research and development are pooled, that there is a policy for standardization, that the best accounting and costing techniques are everywhere adopted, to establish for management new standards of performance and, perhaps most important of all, to establish confidence, loyalty and discipline among the management team—these are not tasks unique to the National Coal Board. They are the permanent tasks, demanding constant attention from the management, of any large industrial undertaking. A sound organization is essential; but it is the ability and integrity of the people working in the organization that count most.

The prime factor in success is the constant exercise of leadership at the highest level; and while the Fleck Committee emphasizes the importance of team-work, it leaves no doubt that decision and effective action at the top are also imperative to ensure that policy is implemented. It will be noted that the Committee insists that team-work must commence at the Board-level, and some of its most outspoken criticism is on this point. Equally it is emphatic that, in the main, the industry should throw up its own leaders, and the Board should pursue positive measures to that end. It is satisfied that the direction of the industry must be largely in the hands of men with experience in the industry, and that normally the industry should breed its own full-time board members; nor does the Committee see any reason why, given an appropriate staff policy, the industry should not throw up such men, capable of taking continuously a wide view on all the issues which the Board has to decide.

The Fleck Committee sees at this point, however, and not in the fact of nationalization as such, a prime cause of some of the difficulties of the British coal industry. From the end of the First World War to the end of the Second, the industry was starved of capital and of technical men. On nationalization it was, for the most part, backward in general and in technical management. The condition of many collieries was poor, and a wide technical renaissance, a large programme of physical reconstruction and greatly improved methods of management are required to enable the industry to meet the country's need for coal. Such a technical renaissance or re-organization will not by itself suffice. Organization itself cannot ensure the use of conciliation machinery in wage disputes, more regular attendance at work, or better discipline in the pits; and while the Fleck Committee recognizes that the Board itself should strengthen at all levels the calibre of the staff dealing with labour problems and adopt clear and resolute policies, it also points out that better leadership is required within the trade unions involved.

The recommendations which more specifically affect the scientist and technologist in the industry, as such, are to be found in the following section of the report, which discusses the headquarters organization of the Board; but they are more appropriately considered in the light of these general observations. In considering the composition of the Board itself, the Committee suggests that the Board's functions could be divided into six main fields: production; marketing and purchasing; industrial relations; staff; finance; and scientific. It proposes that responsibility for medical service should be given to the member of the Board responsible for scientific activities, and that each of these six fields should be the responsibility of a full-time member. It was satisfied that the present committee system works fairly well, though it suggests that the number and size of committees should be kept as small as possible, and it recommends that the system of organizing specialist staff in departments at each level of management should be maintained. For the industry to succeed, there must be leadership at all levels, and in particular leadership from the top. This means that the brains and ability concentrated at headquarters must be of the highest calibre, drawn from the most progressive elements in the industry. Only in this way can new ideas and a new outlook be inculcated throughout the organization.

The Fleck Committee is satisfied that, in the past, departments at headquarters have not always so consistently received the support which is their due and without which their task cannot be properly carried out; for this reason the Committee sets down in some detail its views on the way in which the functional channels should work. These are not indeed new or revolutionary and, as the Committee notes, have operated smoothly and efficiently in the better-run divisions and areas of the industry since the National Coal Board's organization was first established. It recommends specifically that the functional heads at each level of the organization should be of better calibre and higher status than

their functional counterparts at the next level below, and that this seniority should be openly acknowledged and reflected in remuneration. It does not recommend the establishment of a technical advisory service, but considers there is good reason for maintaining at headquarters, at division and at area-levels, specialists in various fields, and that the title 'Director-General' given to heads of existing departments should also be given to the executive heads of the new departments which should be established.

The great need of the industry, however, is better management at all levels, or, in other words, more people of ability, new and better techniques for them to use and firmer discipline; and in reaching this conclusion the Fleck Committee is clearly of the opinion that the industry for many years failed to get the share it should have had of the nation's brain-power and executive ability. While it has recruited from the mining departments of the universities at a level below the industry's needs, on nationalization it lost many of its administrators at a time when managerial and administrative talent were needed more than ever. The Fleck Committee believes that the decisions which the Board took at the outset about the main structure of the new organization were correct; but the consequent administrative and technical posts have not yet been filled by suitable people. Promotion has often been too rapid, and responsible posts are held by those with little knowledge of modern methods of management.

To help meet this situation, the creation of both a staff department and an industrial relations department is recommended; in these fields it is considered that the Board should seek the co-operation of the trade unions, as it does in such fields as safety, health and welfare, but it should not rely as heavily as in the past on the ranks of the trade union officials as a source of recruitment for responsible positions on this side of the Board's work. The Board should itself aim at training people for such positions, drawing largely on the whole body of its own employees. In particular, the Board should be at pains to fill the key posts concerned with personnel adequately, and to strengthen the staff wherever necessary.

The Fleck report suggests no changes in departmental responsibilities in the field of research and development; but it thinks that the present arrangements, under which responsibility for research lies with the Scientific Department and for development with the Production Department, should be broadened and strengthened by setting up a single Research and Development Committee in place of the existing two interdepartmental committees. The setting up of the Central Engineering Establishment should supply the necessary resources for development; but while the National Coal Board admits that the industry needs more development, of the recommendation to establish a Research and Development Committee it is only observed that "the way in which development can be continuously given the right stimulus is under consideration". The recommendation that divisional carbonization directors should be appointed is like-

wise still being considered by the new Board, on which Sir Charles Ellis, scientific member since it was formed in 1946, has been replaced by Dr. William Reid and Mr. A. H. A. Wynn.

A review of the organization of each divisional headquarters with the view of establishing a common pattern of organization and a re-assessment of the staff employed is also recommended, and likewise the laying down of a pattern of area organization which should be adopted by each area with only such variations as may be required by local circumstances. No changes are thought necessary in the size and number of areas. Fundamentally, however, what is required is more determination on the part of the Board itself to see that its policies are carried out, and the severest criticism in the report is to be found at precisely this point.

This is not so much a criticism of decentralization as of its execution, and of a mistaken conception of what decentralization means. Moreover, that mistaken attitude is not confined to the Board itself: it is to be found at all levels, and while the Fleck Committee points out that the Board must insist on its policies being properly carried out by the subordinate formations and ensure that proper discipline exists, the major obstacles arising from bad discipline and the failure to implement properly negotiated agreements are unlikely to be overcome without consultation and co-operation with the trade unions. It is a problem of size that is inherent in all large organizations, both in trade unions themselves and industrial undertakings in general. Causes of friction and misunderstanding can be minimized or removed by the clear statement of the principles of decentralization to be followed, the definition of the powers to be delegated and by greater boldness in making changes in personnel where necessary on account of age, inefficiency or indiscipline. The full effects of reorganization and full efficiency of the industry can only be achieved with the goodwill, understanding and full co-operation of all in it—Board, management and mine-workers—and with the guidance and leadership of the trade unions.

In his Cadman Memorial Lecture to the Royal Society of Arts last January, on research in the coal industry, Dr. W. Idris Jones described the direct representation of science at Board-level, by the initial appointment of Sir Charles Ellis as scientific member, as the most important single change effected by nationalization from the scientific point of view. The Fleck Committee clearly shares the view that the industry needs many scientists. From among these scientists as well as from others of the Board's employees will be drawn the future administrators and managers, including members of the Board itself.

Perhaps the most significant feature of the Fleck report, however, is not this demonstration of the need of the coal industry, or even of industry generally, for highly competent administrators and managers. The need of the National Coal Board for scientific and technical man-power is a factor of which full account must be taken in considering the supply and distribution of the nation's trained man-power. That demand cannot, and should not, be separated from

the demand for managerial and administrative talent in general, which to some extent must be met from technical and scientific sources. What stands out above all from this review of the organization of the National Coal Board is the demand made on management, not simply for technical knowledge and sound judgment, but still more for human understanding and for the moral qualities which leadership implies. Defects of leadership more than anything else appear to be at the root of the Board's difficulties in the past, and they are defects to be found not only at the Board-level but equally at area-level, in the collieries and in the trade unions.

This is not a position peculiar to the National Coal Board. It is equally true of transport and of industry generally, whether nationalized or privately owned. This need for leadership at all levels is a factor of which due account should be taken in recruitment and in the educational policy of Britain. A policy which provides means by which the able recruit entering at the lowest operative level can climb to board level if he possesses the requisite talent will fail of its full effect if, under the educational system, all such talent passes first to the university and enters the industry much higher up the scale. It may even be that the trade unions themselves are already missing talent for leadership which formerly would have come to them from the schools but now goes direct to the university. The indirect consequences of such a changing recruitment pattern can be extremely serious if no measures are taken to deal with the situation. On one hand, it emphasizes the importance of a wide general education which develops not simply technical competence but also human insight and sympathy and judgment. On the other, it points to the need for fostering public understanding of what science is and does, the conditions of technical advance and the functioning of industry, so that co-operation, goodwill and good industrial relations are more easily achieved. These are factors which bear closely on the recruitment and training of men intended for management positions. Little attention is given to such factors, however, in the report issued by the British Institute of Management. Nevertheless, the procedure developed for selecting and training recruits intended for such positions can contribute much to promoting within any firm the spirit of goodwill and understanding, and the climate of opinion upon which co-operation and good industrial relations are invariably based.

That needs to be remembered in any discussion on education for management, if not indeed in discussing technological or university education in general. A policy of recruitment for eventual management posts may be clearly defined, and effective steps taken to make all levels of staff aware of it and co-operative. Training courses may be provided for those selected, whether standardized for the external recruit until he specializes, or for internal nominees depending on their experience, and detailed for each individual in activities and dates for as long a period as practicable. Candidates may also be provided with a fair general statement of future

prospects in the company and given early in their training a comprehensive picture of the organization and its policy, and due care taken in introducing them to each new department, advising them regularly and suitably and terminating the training period with a specific appointment. Such admirable recommendations of the British Institute of Management's Study Group will, however, fail of their full effect unless the education received by those selected for training has been such as to awaken responsiveness to human needs, to the structure and traditions of the society in which they move, and to encourage both vision and a sense of purpose in our civilization.

As Prof. W. R. Niblett remarks in his recent book, "Education and the Modern Mind" (Faber and Faber, Ltd., London), "if leadership is to be released . . . leaders must add vision to intelligence and will, but not merely that: they must be representative of their society, belonging to it profoundly. For unless they do thus belong, they will never feel intimately as disturbingly personal issues the conflicts really important in its life, and so will never be able to fight its battles within themselves". Prof. Niblett was concerned more specifically with the problem of making a school or university more deeply representative of the nation; but his words equally illumine the root problem of leadership, in the coal industry or in any other industry, and the factor with which, above all, training for management must be concerned. Unless leadership in this sense is released, and at all levels, no system of organization is likely to succeed. With it the size of an industry need prove no more obstacle to enterprise and efficiency than in the family concerns out of which large concerns have in the past so often emerged.

ETIOLOGY OF ANTI-SEMITISM

Working-Class Anti-Semite

A Psychological Study in a London Borough. By Dr. James H. Robb. Pp. xiv+239. (London: Tavistock Publications, Ltd., 1954.) 15s. net.

ANTI-SEMITISM is an ugly social phenomenon: it is also a very puzzling one. Those who have studied it most are still divided on the question whether it is to be regarded as a special case of race prejudice or as something unique, with a distinctive etiology.

"Working-Class Anti-Semite" is an important work because it contributes to an answer to this question. It is, moreover, the first large and well-conducted field-study of the problem to be carried out in Great Britain. Dr. J. H. Robb here reports the results of an investigation in the London Borough of Bethnal Green during 1947-49. After gaining useful background experience by serving as a part-time barman in a "local", he conducted an extensive series of interviews with a hundred or so randomly selected representatives of the working-class population. The purpose of these interviews had, of course, to be suitably disguised. Dr. Robb displayed quite remarkable ingenuity and skill in obtaining the information he desired through these informal doorstep conversations, and in reducing the raw data to terms which enabled statistical methods of some

precision to be used. He was able to assess his subjects for anti-Semitism and for a number of personality variables. He even persuaded a considerable number of them to submit themselves to a Rorschach test. His conclusions are based mainly on the data obtained from the two sub-groups representing respectively the extremes of prejudice and the extremes of tolerance. The members of these groups had mostly been subjected to longer interviews and to the Rorschach test.

Even his negative conclusions are important. No statistically significant relation could be found between anti-Semitism and either political allegiance or with experience of employment with Jewish employers or workmates. Nor was there any association of anti-Semitism with either residence in a Jewish neighbourhood, or with social class or "socio-economic status". These conclusions should at least help to deflect further research from the less to the more, promising avenues of exploration.

Among positive findings, the first to be stated is that the level of prejudice in Bethnal Green is higher than is found elsewhere in comparable studies. This conclusion, though not unpalatable, is not too well supported by the evidence adduced, and the statement out of its context could be exceedingly misleading. Detailed study of the facts reported leaves the impression that anti-Semitic prejudice in Bethnal Green is less pronounced than might well have been expected. The contrary impression would seem to depend on three shaky assumptions: that Dr. Robb's five-point scale can be equated to the scales used in other investigations; that the comparison can be made chiefly on the basis of comparing the percentage of tolerants; and that all the scales in question measure a single continuous variable.

The actual distribution of anti-Semitic opinion is seen in Table 7 of the work, which shows only 8.7 per cent to be extremely intolerant and 17.5 per cent at the extreme of tolerance; the three intervening steps are respectively 17.5 per cent in grade 2, 13.6 per cent in grade 3 and 42.7 per cent in grade 4. These figures suggest a bimodal distribution in which about one-third of the population distributes itself around the prejudiced mode and two-thirds around the mode of tolerance. Moreover, all figures have to be interpreted in the light of the author's statement that his rating scale tended to exaggerate the degree of intolerance shown.

The author's first conclusion, however, is much less important than the second, which is much better supported by the evidence—namely, that anti-Semitic prejudice is strongly associated with certain more general deviations from normality in the selected personality variables. The more extremely prejudiced differ from the more tolerant in ways that suggest that the former display a sense of insecurity, anxiety, an ambivalent attitude to authority and in traits which range from symptoms of neurosis to those of psychosis. Dr. Robb traces the syndrome in part to constitutional factors and in part to factors which condition development from infancy to maturity within the culture pattern of the Bethnal Green community.

His book retains some of the stigmata of the Ph.D. thesis—a rather too complete survey of previous research, too frequent apologies for not attempting the impossible, and rather over-detailed discussion of methodological niceties—but these are trivial defects in a work of such exceptional interest and importance. The importance is not entirely theoretical. The chief

conclusions support the view that anti-Semitism is not an isolated phenomenon but is symptomatic of a more general condition of maladjustment. This makes it no easier to deal with; but there is consolation to be derived from the reflexion that whatever prevents or cures the development of anti-Semitic prejudice will also prevent or cure the development of many other disorders of personality.

C. A. MAOE

LANDSCAPE OF BRITAIN

Man and the Land

By Prof. L. Dudley Stamp. (The New Naturalist Series: a Survey of British Natural History.) Pp. xvi+272+56 plates. (London: William Collins, Sons and Co., Ltd. 1955.) 25s. net.

PROF. L. DUDLEY STAMP'S second contribution to the "New Naturalist Series" forms a fascinating sequel to his first, which was concerned with the geological evolution of the topography of the British Isles and with showing the influence of structure upon scenery; the present book deals with the influence of the hand of man in shaping the landscape as we see it to-day.

For two thousand years our scenery has undergone a gradual process of evolution while the land has been cleared of its natural vegetation to make way for man's crops and domestic animals, a process which has never stopped, and will continue. "Very little indeed of the scenery, even in the wildest and least touched parts of our islands, can be truthfully described as natural." Is man, then, always to be regarded as unnatural? Surely he is as much a part of the fauna as the other animals, in spite of his arrogance in setting himself above it: a newly established nesting colony of herring gulls, for example, can, by altering the local ecological conditions, change the scenery proportionately as much as a colony of men setting up a new suburb or airfield. There are, however, aesthetic standards for man, and, if he takes the trouble to think, he does know something of what he is doing. Evolution in scenery, as in all else, will go on whether man likes it or not: "our land is clothed with a living mantle and tenanted by living creatures. All living things are born, mature, decay, and die, to be replaced in due course by others which are different. However much therefore we may enjoy a particular phase of scenic evolution it is not a conversation piece to be framed and hung upon the walls of a museum or art gallery. It is alive, and our task is so to direct its growth that we create beauty, not destroy it. . . . So my story is the elimination of wild nature at the hand of man over the ages, and the gradual substitution of a landscape largely of his making, clothed with trees and plants of his choice, and tenanted by animals which he has either tended or tolerated".

Prof. Dudley Stamp surveys the whole history of the evolution of British topography since the end of the last glaciation some fourteen thousand years ago, and particularly since the arrival of Neolithic man some seven thousand years ago. He deals with the influence of the early invaders, both before the Romans and after, and with the evolution of agriculture and husbandry; his chapters on the improvements in cropping and in the breeds of domestic stock are particularly interesting, as are those on the

introduced trees, plants and animals. His last two chapters on the gradual realization by man that the slow process of evolution under his influence was rapidly gaining speed under the pressure of expanding population, and that it might be going in a direction that would produce results not to his liking, are extremely important. They give a lucid summary of the legislative and other measures that have been taken in order consciously to influence this evolution, and point out how essential it is that we should know what we are doing and why. "The comprehensive land-use planning upon which we, as a nation, have embarked is doomed to fail unless we understand the present position and the factors which have led up to it." This is a splendid book, and the illustrations alone make one glad and proud to be a native of this green and pleasant land.

L. HARRISON MATTHEWS

THE PATHOLOGY OF CO-OPERATION IN INDUSTRY

Mental Health and Human Relations in Industry

Edited by T. M. Ling. Pp. xix+266+1 plate.
(London: H. K. Lewis and Co., Ltd., 1954.) 21s. net.

THIS is indeed a worth-while book. Written at 'university level', it is in the best traditions of Elton Mayo's pioneer studies of the human and social problems of an industrial civilization, and, in British literature, is a worthy successor to the Elliott Jaques study of the Glacier Metal Company (reviewed in *Nature*, 169, 85 (1952), under the title "The Anatomy of Co-operation"). The content of the book is in the main, to quote from Lord Horder's admirable foreword, "the record of Roffey Park, that significant experiment in social medicine".

There is no pretence at erudite analysis, no descent to the pseudo-mysteries of technical terminology. The editor and associate authors have accomplished the no mean achievement of presenting a simple and straightforward text-book study of the human animal's reactions to the social atmosphere in which he works, and in particular to the more unsatisfactory and negative factors in that atmosphere. "The very fact that people work together for a common purpose provides a complex situation that may be of benefit or of harm to its participants: human relations are promoted when such complex situations prove beneficial, and mental illness is probable where the 'climate' is persistently disharmonious". Lest the aim to contribute to the study of such subjects, within the universities, should appear to the layman, to be academic, there is a useful and inter-related emphasis in both the first and the last chapters on the significance of such subjects to the man of practical affairs. "The University-trained engineers, economists or physicists often achieve positions where their technical skills and experience are subordinated to the use of social skills . . . [but] many of them have only a vague appreciation of the psycho-social problems which confront them" (Chapter 1). "Every manager and administrator, though often unaware of the fact, succeeds in the end through people . . . even the production of atomic energy must be planned by men and made through men's efforts" (Chapter 14).

Moving off from the foundation of a recapitulation of Mayo's observations on the social fragmentation

and other ill-effects of rapid change inherent in the process of industrial advancement, the authors proceed to describe, explain and analyse the behaviour of the individual who is "perplexed by anxieties, apathy and withdrawal"—the manifestations appearing in inefficient working, absence, ill-health, careless work, strikes, and (when translated to the non-occupational environment) in communal difficulties and domestic disorders. "Neurosis," it is recalled from one research study, "is probably the largest cause of loss of working time in industry." Nor is this a deliberate creation of man's volitional cussedness—rather is it an essential by-product of his emotional and gregarious nature. Herein lies the true significance of this study as a contribution to training for management: not that managers are expected to become technically expert in the intricacies of social psychology, but they should be aware of the social problem inherent in their command of men and alive to its significance for their own executive behaviour and skill.

Chapter 4 is probably a pioneer in the annals of management literature—a review of "aggression in industry". "Aggression in one form or other often does, but need not, play a large part for ill in industrial relations; many of these ill effects could be avoided if as much study and discipline were used in the control of aggression as is commonly spent on favourite sports or hobbies." Basic to such control is the understanding of our own and other people's emotions. The following chapters consider constructively the patterns of behaviour that have to be interpreted in this process of understanding, and show how the ordinary manager can be assisted by the specialist services of personnel advisor or psychiatrist. In these directions the factual material that has been garnered from the harvest of Roffey Park's care, study and cure of several thousand 'patients' from industry makes its most valuable contribution. In Chapter 10 the threads begin to be drawn together in the plea for more attention to research in management practice: without research, whether on an operational basis or on the lines that Roffey Park's clinical facilities have provided, there can be no reliable knowledge of social disorders and their etiology, and thus no systematic approach to remedies. Nor can there be material for teaching.

To the practising manager this book will probably offer more than to the neophyte, because he will recognize in its every example a parallel to his own experience and a pointer to some of his own (unintended) failures; and in the simple schedule on p. 187 he will have basic articles of faith for his own and his subordinates' guidance, beginning with the dogma that "man is a social animal"—philosophically rational, but operationally emotional. It is here, perhaps, that the authors might have found a lesson from their own research: several of them are bothered whether management is "a science or an art". Had they recognized it more readily as "a process", they could have borne home more keenly the moral of the manager's own share in social emotional patterns that circumscribe his everyday work: "too often [the manager] fails", says one of the authors, "because he does not feel personally the issues involved: over-confidence produces blindness, and lack of confidence the loose rein". Ignorance, he might have added, produces the blundering command that sends many more than six hundred industrial casualties into metaphorical valleys of death.

E. F. L. BRECH

RADIOLOGICAL HAZARDS FROM NUCLEAR EXPLOSIONS AND NUCLEAR POWER*

By SIR JOHN COCKCROFT, K.C.B., C.B.E., F.R.S.

Intensity of Radiation from Nuclear Explosions

THERE has recently been a considerable amount of discussion in Parliament and elsewhere on the biological effects of nuclear explosions. The greatest interest appears to be taken in the world-wide contamination which comes from test explosions. The most important source of contamination is the hydrogen bomb, since it produces 100–1,000 times more radioactive products than an atom bomb. The contamination is, however, of the same kind. The same radioactive fission products are produced and their activity decays in the same way. Thus the γ -ray intensity decreases by a factor of 50 between one hour after the explosion and one day. By the end of ten days it has decreased by a further factor of 20, and by a hundred days by a further factor of 10.

The explosion of a hydrogen bomb on the ground mixes millions of tons of soil with the radioactive products. Particles of all sizes from 1/50 in. diameter down to less than a thousandth of an inch are produced. These particles are transported by the wind. The larger particles fall out quickly. At Bikini they contaminated heavily a cigar-shaped area of the order of 7,000 square miles—220 miles long and about 40 miles wide. A large proportion of the radioactivity may come down in this local fall-out of the larger particles. The remainder of the radioactivity is carried into the stratosphere—above 50,000 ft.—and is carried on very fine particles. These are carried round and round the world, gradually spreading out and falling out slowly over a period of years.

Air-burst hydrogen bombs differ from ground-burst bombs in that practically all the radioactivity will go into the stratosphere and from there be deposited fairly uniformly.

In Great Britain we have monitored the contamination of the atmosphere by flights with aeroplanes carrying filters and by measurement of the radioactivity precipitated in rain water. From the aeroplane measurements we know that the intensity of radioactivity in the stratosphere arising from the explosion is very much greater than the activity at ground-level. From the rain-water measurements we can determine the amount of radioactive contamination which is deposited on the ground. We can then calculate an upper limit to the γ -radiation which is emitted by assuming that the radioactive products have not diffused far into the ground and that the radiations from them are not appreciably absorbed.

We find that the average concentration of radioactivity in the air at ground-level during the past three years due to bomb explosions of all types is about 1 per cent of the average natural radioactive dust content. The highest peak of activity was half the average natural level. The natural level itself fluctuates, and in some periods reaches fifteen times the average level. This is probably due to changes with meteorological conditions in the concentration

of the natural radioactive gas, radon, which comes out of the ground. Prof. W. V. Mayneord has observed even higher fluctuations in London in special meteorological conditions, and these may be connected with the combustion of fuel.

Coming now to the radiation or radioactivity effects of bomb explosions on human beings, the accumulated dose which will ultimately have been received in Britain by completely unprotected people from the fall-out which has so far occurred is about 0.01 r. An additional dose will be received from the fall-out of the debris which is still airborne. This is expected to increase the total dose to 0.03 r. In the United States, where local fall-out from Nevada is important, the average dose received from bombs so far exploded will total 0.1 r. The actual dose varies by a factor of 2 in different areas.

It is important to note, however, that the radiation is strongly absorbed by brick houses, and in the lower part of a house the radiation-level is decreased about twenty times. Since the average person spends a good deal of time indoors, the dose received will be reduced by a factor of at least 10. The radiation will also be reduced by the washing of the radioactivity down drains and into crevices in the ground; the average dose in Britain is thus likely to be less than 0.003 r. over a generation. How small this is can be judged from the fact that natural sources of radiation in the ground, cosmic rays and the natural radioactivity of the human body give us each a dose of 3 r. over a generation of thirty years, and that in some parts of the world—such as Tibet—where the cosmic ray bombardment is more intense, the dose goes up to 5 r. without any very obvious effects. So our additional dose from bombs so far exploded is something like a thousand times less than our natural dose.

Genetic Effects of Radiation

I will now turn to the much debated genetic effects, speaking with diffidence as a physicist. The effect of radiation is to increase the natural mutation-rate of the genes responsible for transmission of hereditary characteristics. The mutations produced by radiation are identical with the naturally occurring mutations, which have widely varying effects, ranging from pre-natal death and serious malformation to minor disabilities, such as loss of fitness, personality defects and minor mental changes. For example, one troublesome natural gene produces about two thousand abnormalities of a particular type in our population. These mutant genes are transmitted from generation to generation as a genetic load of ill-health until they are eliminated by death before reproduction or failure to reproduce.

Dr. H. J. Muller, one of the leading geneticists of the world, considers that to double the natural mutation-rate generation after generation would produce disastrous results in a civilized population. In his opinion, it is advisable as a protective measure to limit the dose received before reproduction to a quarter of the doubling dose—so that the mutation-

* Address to the Parliamentary and Scientific Committee, delivered on April 20.

rate would not be increased by more than 25 per cent. It is probably fair to say that the opinion of geneticists would differ widely on the maximum permissible level.

The best evidence on the radiation dose required to double the natural mutation-rate in mammals comes from experiments with large doses of radiation on mice in the Oak Ridge Laboratory of the U.S. Atomic Energy Commission. These suggest a doubling dose of about 50 r. for mice. The extrapolation from mice to men is obviously an uncertain one. There is also a variation from gene to gene. If we accept Dr. Muller's criterion and apply the mice results to men, it would restrict us to a dose of 12.5 r. per generation.

I have said that from the bombs exploded so far the radiation dose received by most of us, shielded by houses and offices, will be less than 0.003 r. per generation. We are therefore several thousand times below Dr. Muller's maximum level and our additional dose from bombs so far exploded is perhaps a thousand times less than the dose we received from natural sources.

Other harmful effects of test explosions have been suggested in a recent communication by M. Charles Noel-Martin to the Paris Academy of Sciences. He suggested that a 20-megaton bomb could form 500,000 tons of nitrous oxide gas, leading to production of nitric acid and a harmful increase in the acidity of rain water. He also stated that a ground explosion of this magnitude would send up 1,000 million tons of matter and that this would appreciably diminish the transmission of solar radiation; and that enough radioactive carbon-14 might be formed to increase the natural radiocarbon content of the atmosphere by 10-30 per cent.

We have made some estimates of these effects at Harwell. American figures for the production of nitric acid by explosions suggest that M. Martin's figure is about ten times too high. The amount produced by thunderstorms every day is likely to be about equal to that for one hydrogen bomb explosion, so this effect cannot be important.

We have experience from the Krakatoa volcano explosion (1883) of a diminution of 10 per cent in the intensity of sunlight at the earth's surface due to the dust thrown into the atmosphere. This has been variously estimated at between 100 million tons and a figure 200 times higher. This great amount of dust had no effect upon the weather. Our own measurements of the amount of additional dust in the atmosphere due to nuclear explosions suggest that it is thirty times lower than M. Noel-Martin's estimates. The effect on solar radiation and weather must therefore be extremely small.

The radioactive carbon produced by a large thermonuclear explosion has been estimated at 300,000 curies. This will rise into the stratosphere and diffuse slowly downwards. The equilibrium amount will then be only one-thousandth of the amount naturally present in the atmosphere—produced by cosmic rays. Since the natural carbon-14 contributes only 1 per cent of the natural dose to the human body, the effect is negligible.

If we turn from test explosions to the radiological effects of a full-scale hydrogen bomb war, the picture is a very different one. A great deal of information has been released by the U.S. Atomic Energy Commission on the radioactive fall-out from the Bikini H-bomb explosion of March 1, 1954. The Commission has reported that an elongated cigar-shaped area down-wind from the explosion about 200 miles

long by up to 40 miles wide was heavily contaminated by the radioactive fall-out. In an area 140 miles in length and up to 20 miles in width, the lives of all persons who did not take shelter would have been seriously threatened. For example, on one part of Rongelap Atoll, 110 miles away, the total dose in 36 hr. was 2,000 r.

Some distance farther from the point of detonation, at about 160 miles down-wind and along the axis of the ellipse, the amount of radioactivity would have seriously threatened the lives of about one-half the persons in the area who failed to take protective measures, that is, proper shelter from the radiation. It is estimated that the radiation dosage at that point was about 500 r. for the first 36-hr. period.

Near the outer edge of the cigar-shaped area and extending to approximately 190 miles down-wind, it is estimated that the level of radioactivity would have been sufficient to have seriously threatened the lives of 5-10 per cent of persons who might have remained exposed out of doors for the first 36 hr. In this area the radiation dosage is estimated at about 300 r. for the first 36-hr. period.

The Japanese fishermen at a distance of 85 miles from the explosion received a dose estimated by Japanese radiologists as greater than 100 r.

The Home Secretary has spoken in the defence debate on the consequences of fall-out for civil defence in Great Britain. Those living outside the areas destroyed by blast and heat but exposed to heavy radiation would have at once to seek shelter in houses or other buildings. Measurements carried out at Harwell have shown that an ordinary brick house would probably reduce the intensity of radiation by a factor of at least 20, while additional shelter can be provided by a cellar or slit trench. It has been said in the United States that an old-fashioned cyclone cellar with a covering of earth 3 ft. thick reduces the radiation intensity by 5,000. Having taken shelter, the occupants would have to stay inside until the radiation intensity had fallen to such a level that they could go out—at first for short intervals and then for longer periods. However, even after one week from the explosion, 36 per cent of the total dose has still to be delivered. In other words, in a zone contaminated so that the total long-term dose would have been 1,000 r., people coming out of shelter after one week for eight hours a day could still receive a long-term dose of 120 r. In these circumstances, a very large part of the population might receive more than the doubling dose. It is scarcely conceivable, however, that such an experience could recur in successive generations, and the genetic effect would seem to be a minor part of the overall catastrophe.

The world-wide contamination from a full-scale hydrogen bomb war can best be estimated by scaling up our estimate of the dose of 0.03 r. which would be received in the open in Britain from all bombs exploded so far. If the number of hydrogen bombs were to be 1,000 times the number so far exploded—which seems very unlikely—there would be a hemisphere contamination corresponding to a dose of about 25 r. This would be somewhat beyond Dr. Muller's danger-level if the experience were to be repeated generation after generation.

Before I leave this subject, I will try to dispose of another popular horror—the so-called cobalt bomb. There seems to be a general belief that still more lethal types of bombs could be produced by incorporating cobalt into a hydrogen bomb, and that such

bombs might poison the whole earth. Our studies lead us to the conclusion that there is nothing in this idea—the cobalt bomb would offer no advantages to a lunatic designer.

Radiation from Nuclear Power Development

The large-scale development of nuclear power from uranium fission will necessarily produce large amounts of radioactive waste products having properties identical with those produced in nuclear explosions. The radiations are, however, mainly confined to the nuclear reactors which are the source of heat for nuclear power stations, and to the chemical plants where the radioactive wastes are extracted from the spent uranium fuel.

The radiation in the vicinity of the nuclear power units can be kept below the internationally agreed safe levels without difficulty by the use of suitable shielding. The average radiation dose received by Harwell workers is 0.25 r. per annum. This is one-sixtieth only of the level agreed internationally as permissible for workers employed in such circumstances. The chief hazards at Harwell so far have been the usual type of industrial accident.

The public health problems are thus largely transferred to the chemical processing plants. The radioactive waste products include radioactive gases, such as radiokrypton and xenon; these are at present allowed to escape from the processing plant in conformity with safety regulations, providing that no harm can be caused to the neighbourhood. It is likely that in future they will be bottled and turned to useful purposes. The emission of gaseous wastes will not increase to any significant extent as we develop the atomic power programme.

The radioactive solid wastes can be divided into three groups, only one of which presents a serious problem. The first group contains those isotopes which are only slightly radioactive; these are comparable to the natural radioactive elements of the earth's crust, and dispersal is a satisfactory method of dealing with this group. The second group consists of the great majority of the radioelements produced in fission, and these decay fairly rapidly. Storage of this group, for a period of say ten years, would reduce the activity to a level at which dispersal would be practicable and completely safe.

The third group is the one which presents difficulties. It consists essentially of two elements, strontium and caesium. Each of these has an isotope which decays moderately slowly, so that dispersal would only be possible after an unreasonably long storage period (hundreds of years). These two isotopes are finding increasing use in industry and medicine, and it appears there will be a commercial market for all available quantities of them for the next few years. Chemical separation of these isotopes will enable the Atomic Energy Authority not only to dispose of the first two groups without difficulty but also to market a valuable by-product.

It will, of course, be necessary to apply the same standard of radiation protection as has been adopted in the Atomic Energy Authority. By the time the supply of strontium and caesium exceeds the demand, the methods of permanent storage of these isotopes, on which work is proceeding vigorously, will have been fully worked out. The present safe procedures of disposal at sea and of long-term storage may still be valuable for a small amount of certain types of high-activity waste; but it is probable that newer

methods will supersede them. The problems of radioactive wastes in the atomic power programme seem likely to be solved by the technological developments now in hand.

General Conclusions

The level of radioactive contamination in the world produced by all the nuclear bomb explosions and peaceful atomic energy activities is at present so low that it should not cause any anxiety. The radiation level which would give rise to serious harmful effects is probably at least a thousand times the present level of contamination. We do not at present know this figure with any accuracy, and long-term genetic studies are required to determine this. A Committee of the Medical Research Council has been formed to investigate these problems; this will in due course produce a better assessment of the position than I have been able to do here.

BIOCHEMISTRY OF VITAMIN B₁₂

THE latest of the valuable series of symposia arranged by the Biochemical Society had as its topic the biochemistry and functions of vitamin B₁₂. This truly remarkable substance was isolated only seven years ago. Its close connexion with a mortal disease of man and its importance in animal nutrition fired the interest of workers in many laboratories, and progress in its study has been encouragingly rapid.

Dr. E. Lester Smith (Glaxo Laboratories, Ltd.), the first speaker, reviewed the isolation and chemistry of vitamin B₁₂ and described the unravelling of its structure, in which the Glaxo workers so fruitfully joined hands with Sir Alexander Todd's group in Cambridge and Dr. Dorothy Hodgkin in Oxford. He recalled the fascinating story of how he and his colleagues almost simultaneously with the Merck group in the United States produced the crystalline vitamin from liver, which contains only one part of it per million, with only clinical tests as guide. Liver is now entirely uneconomical for large-scale preparation. Commercial production is by fermentation, and the vitamin comes either from spent liquors in the manufacture of streptomycin and aureomycin or is made by a variety of micro-organisms in special fermentation. Dr. Smith outlined some of the steps of its isolation from such materials, in which chromatography plays an important and essential part.

The molecular weight of cyanocobalamin (vitamin B₁₂) is about 1,350 for the anhydrous substance, and the empirical formula lies within the limits C₆₁₋₆₄ H₈₄₋₉₂ O₁₃₋₁₄ N₁₄ P Co. The cyanide group attached to the central cobalt atom may be replaced by other acid radicals, giving rise, for example, to nitritocobalamin (vitamin B_{12c}) and hydroxocobalamin (vitamin B_{12b}). Hydrolysis with warm acid splits off the characteristic 'nucleotide', 5:6-dimethyl-1-(α -D-ribofuranosyl) benzimidazole-2' (or 3') phosphate, the rest of the molecule being the naturally occurring factor B, the parent substance of the whole family of vitamin B₁₂-like factors so far described, more fully considered by the next speaker. Hydrolysis of vitamin B₁₂ with cold 2N hydrochloric acid in the presence of nitrite leads to the formation of a series of red carboxylic acids containing one to six acidic groups and still retaining the nucleotide,

and of another series of seven orange-coloured acids • that have lost the nucleotide (that is, are derived from factor B). Of factor B itself and its derivatives, only the hexa acid has yet been crystallized, and it is this compound that proved so useful in further crystallographic study. The hydrolytic procedures reveal the presence within the vitamin B₁₂ molecule of six CONH₂ groups, the nucleotide attachment being provided by a seventh, D_g-1-aminopropan-2-ol forming the link, with the amide at one end and phosphoric ester at the other. The second phosphoric acid hydroxyl is accounted for by attachment to ribose. Consideration of the properties of the molecule leads to the concept that the third hydroxyl is masked by internal salt formation in vitamin B₁₂ itself, the centre co-ordination complex in it being basic and neutralized by the phosphoric acid group on the rest of the molecule, a configuration supported by X-ray crystallographic examination at Oxford.

The crystallographic approach has proved astonishingly fruitful and has yielded a deep insight into the structure around the cobalt atom; this is almost that of a porphyrin, the difference being that in vitamin B₁₂ two of the four rings are directly linked without any bridging atom. As pointed out by Dr. Dorothy Hodgkin in the discussion, X-ray crystallography indicates that this inner nucleus is attached to a system of acetic and propionic acid residues. The usefulness of the X-ray work is further demonstrated by its fixing the point of attachment of the phosphate to the third position on the ribose chain.

The introduction of labelled atoms into vitamin B₁₂ is of great value in analytical, microbiological and, especially, clinical work, and Dr. Lester Smith described the preparation for haematological studies of vitamin B₁₂ labelled with all four available radioactive isotopes of cobalt.

Dr. S. K. Kon (National Institute for Research in Dairying, Shinfield, near Reading) described other factors related to vitamin B₁₂. Examination of natural materials that have undergone microbial fermentation, such as rumen and gut contents, faeces, silage and the like, by methods similar to those used for the isolation of vitamin B₁₂, reveals in them the presence of red, cobalt-containing pigments closely related to vitamin B₁₂ but differing from it in microbiological activity and, with one exception, absence of growth-promoting properties for animals. Through efforts of workers at Shinfield and at Glaxo Laboratories, of Wijnenga in Holland, of Pfiffner in the United States, and of Bernhauer in Germany, some ten such substances have been separated and six so far characterized in reasonable detail. One of these is factor B, and the other five differ chemically from vitamin B₁₂ only in the nature of the nucleotide. Thus, in pseudovitamin B₁₂, adenine instead of 5:6-dimethylbenzimidazole is the nitrogenous base. Factor A contains 2-methyladenine, a purine hitherto not encountered in Nature, and factors G and H contain respectively hypoxanthine and 2-methylhypoxanthine. The base of the fifth factor, vitamin B₁₂III, which also yields factor B on hydrolysis, is not yet known, though it is probably not a purine derivative. Vitamin B₁₂III is the only naturally occurring vitamin B₁₂-like factor so far tested found to be active in pernicious anaemia. Though they may have no direct function in the animal, their microbiological activity indicates that these vitamin B₁₂-like factors may be important metabolites for micro-organisms, necessary, for example, for the proper functioning of the rumen or

gut flora. The Shinfield workers were able to prepare factor A and pseudovitamin B₁₂ in guided biosynthesis by offering factor B and the corresponding nitrogenous base to a *Bacterium coli* mutant; and with substituted purine compounds and with benzimidazole derivatives they obtained in this way a series of new, 'unnatural' analogues of which the monomethylbenzimidazole, and the benzimidazole one also obtained by Fantes and O'Callaghan by adding *o*-phenylenediamine during fermentation of *Streptomyces griseus*, were of particular interest because of their activity for higher animals mentioned later on in this summary article. 9-β-Ribose derivatives of adenine were not incorporated, in agreement with Dr. Hodgkin's statement that only 7-α-derivatives would fit into the molecular structure of vitamin B₁₂. The biosynthetic approach opens up possibilities of production of vitamin B₁₂-like factors with vitamin or antivitamin function.

In a joint paper, Dr. M. E. Coates and Dr. J. E. Ford (National Institute for Research in Dairying) considered the methods of measurement of vitamin B₁₂. Physical and chemical tests are insensitive and non-specific, but have a limited application in the control and standardization of manufacture. Some of the microbiological techniques are susceptible to interference by vitamin B₁₂-like compounds; but as these are present only in traces in animal products, care in the selection of the method has to be exercised mostly with substances that have undergone bacterial fermentation. Of commonly used test organisms, only the protozoan, *Ochromonas malhamensis*, resembles the higher animals in its pattern of response to the B₁₂-vitamins. In the preparation of extracts for the microbiological assay, the addition of traces of cyanide not only facilitates extraction by displacing protein or peptide groups originally linked to the vitamin, but also converts the B₁₂ compounds to their stable cyano forms.

In the biological assay of vitamin B₁₂, it is necessary to deplete the reserves of the test animals either by restricting the vitamin B₁₂ intake of the dams or by imposing on the animals themselves stress factors in the diet. The chick is more suitable for the assay than the rat; but both may over-estimate the potency of crude materials containing unidentified growth factors unrelated to vitamin B₁₂. The presence of vitamin B₁₂-like compounds is less likely to complicate animal assays, since, of the naturally occurring ones, only vitamin B₁₂III is active, and that only to the extent of one-twentieth of the activity of vitamin B₁₂. The 'unnatural' benzimidazole analogue of vitamin B₁₂ is, however, one-third as active as vitamin B₁₂. (The monomethylbenzimidazole analogue has since proved more active than the benzimidazole one.)

Although biological methods give a measure of the physiological availability for the test species, there is evidence that some of the naturally occurring bound forms of vitamin B₁₂ may be poorly utilized by animals unrelated to the species from which the binding factor originates.

Drs. D. L. Mollin and S. J. Baker (Department of Pathology (Haematology), Postgraduate Medical School of London) considered the absorption and excretion of vitamin B₁₂ in man. The introduction of radioactive vitamin B₁₂ has simplified the diagnosis of the various vitamin B₁₂ malabsorption syndromes and has led to the development of methods of study of absorption and utilization of vitamin B₁₂ in health and disease. In this connexion the short-lived

isotopes of cobalt, cobalt-58, -57 and -56, have been specially useful, since vitamin B₁₂ labelled with them can be given repeatedly and at high specific activity. The uptake of vitamin B₁₂ is determined by measuring the amount of a test dose excreted in the faeces, or, more simply but rather less accurately, in the urine; and in this way the effect and the activity of intrinsic factor preparations can be studied. The excretion method can also be combined with direct measurement of hepatic storage by applying a directional scintillation counter over the liver. By all such studies, linked with the microbiological assay of vitamin B₁₂ in the serum, the earliest stage of vitamin B₁₂ deficiency can be established and the causes of the deficiency can be separated from its effects. Until, however, accurate methods for measuring the absorption and utilization of folic acid are also available, the pathogenesis of the megaloblastic anaemias in man will be only imperfectly understood.

This paper was followed by one by Dr. A. L. Latner (Department of Pathology, Royal Victoria Infirmary, Newcastle) on the intrinsic factor. After reviewing Castle's classical experiments that led him to the definition of the intrinsic factor, and the methods of preparation and assay of active concentrates, Dr. Latner described his preparation from human gastric juice and from the gastric mucosa of the pig of a clinically highly active mucoprotein with a molecular weight around 17,000. This mucoprotein formed a complex with vitamin B₁₂, containing far less cyanocobalamin than would be expected on a 1:1 molecular basis. Dr. Andresen in Denmark prepared a complex of the same order of activity as Dr. Latner's mucoprotein but of a molecular weight around 70,000, and it seemed possible that the vitamin in the complex was acting as a cross-linkage between several molecules of the intrinsic factor. Work done in Dr. Latner's laboratory on the faecal excretion of vitamin B₁₂ by normal and gastrectomized rats produced evidence for a species specificity of intrinsic factor.

Dr. H. R. V. Arnstein (National Institute for Medical Research, Mill Hill, London) discussed the function of vitamin B₁₂ in animal metabolism. Of all the metabolic reactions in which its function has been suggested, only the biosynthesis of methyl groups is known with certainty to be affected by vitamin B₁₂. Dr. Arnstein's studies indicate that vitamin B₁₂ probably acts in the metabolic formation of these groups from serine, glycine and formate. When these compounds, labelled with carbon-14, were given to vitamin B₁₂-deficient rats, the incorporation of the labelled carbon was 60-70 per cent greater in the presence of vitamin B₁₂. Dr. Arnstein suggested that the site of action may be in the formation of an intermediate, such as hydroxymethylhomocysteine, in methionine synthesis, or perhaps in the reduction of such a hydroxymethyl to a methyl group. Experimental evidence shows that vitamin B₁₂ is not involved in direct transmethylation, or in the interconversion of serine and glycine, which requires folic acid and pyridoxin. Vitamin B₁₂ also brings about increased synthesis of choline from methionine by its effect on the *de novo* synthesis of methyl groups. The influence of vitamin B₁₂ on synthesis of methionine and choline is only indicative of other and more important metabolic functions, still imperfectly understood.

In the last paper, Drs. J. Lascelles and J. Cross (Department of Biochemistry, University of Oxford)

reviewed the function of vitamin B₁₂ in micro-organisms.

The vitamin has been shown to act, directly or indirectly, in numerous metabolic processes within the cell. Species of *Bacterium coli*, some with an induced requirement for vitamin B₁₂, have been extensively studied. The evidence points largely to the conclusion that, in this group, the vitamin operates fundamentally in the synthesis of methionine, most probably at the stage of methylation of homocysteine; but the precise mechanism by which the vitamin acts is still obscure.

In a second group of micro-organisms, represented by *Lactobacillus leichmannii*, the vitamin has been identified with the synthesis of deoxyribosides. Methionine is needed for growth, even in the presence of the vitamin.

The functions of vitamin B₁₂ are evidently closely interconnected with those of 'folic acid', though the two probably act at different levels in biosynthetic reactions.

In certain *Chryseomonads*, and in a species of *Flavobacterium*, the requirement for vitamin B₁₂ is only partly satisfied by methionine, and it is clear that the vitamin functions in micro-organisms in other processes apart from the formation of methionine and nucleic acid derivatives; but there are still no firm indications of what these are.

The general impression conveyed by this stimulating symposium was that, for the time being, the art of the chemist in unravelling the complicated structure of a remarkable substance has outstripped the efforts of physiologists and biochemists in defining the fundamental synthetic process that may well underlie the present diversity of known functions.

RESEARCH INVESTIGATIONS OF THE CENTRAL ELECTRICITY AUTHORITY

By Dr. J. S. FORREST

Director of Research Laboratories, Leatherhead, Surrey

OPINIONS differ as to the extent to which users, in contradistinction to manufacturers, should engage in research; but so far as the Central Electricity Authority is concerned, the question is settled by the 1947 Electricity Act, which states that "it shall be the duty of the Central Authority to conduct research into matters affecting the supply of electricity".

The Authority's research activities can be broadly classified into three groups: (a) research carried out by the Authority and area boards; (b) co-operative research under the aegis of a research association or in conjunction with manufacturers or other users; and (c) research carried out for the Authority by universities or other organizations.

The way a particular problem is dealt with depends broadly on the nature of the problem and the prospects of finding an early solution. Thus the work carried out directly by the Authority in its laboratories and power stations arises mainly from specific operational problems to which an answer is required in the shortest possible time. Problems of more general interest to both manufacturers and users are referred to the appropriate research association.

Fundamental work, which is not expected to lead to any immediate practical applications but which may in time have far-reaching effects, is done mainly at universities, and research contracts are placed on the advice of the Authority's Research Council, with the university department which may be willing, and is best fitted, to carry out the work.

It should be emphasized that no attempt is made to plan research in detail, and in practice the organization of the Authority's research programme is very flexible, so that changes in the scope of the work can easily be catered for and full advantage taken of the research staff and facilities available from time to time.

A few examples of the work in progress in the fields of generation, transmission, distribution and utilization of electricity will give a better idea of the scope and organization of the Authority's research work. It must be emphasized, however, that in a short article only a few of the main researches can be mentioned, and it is not possible to do justice to much of the interesting work carried out by many of the government establishments, research associations and universities of Great Britain on behalf of the Central Electricity Authority.

As is well known, thermodynamic laws and the limitations of existing materials set an upper value to the thermal efficiency of generating plant. Steady progress has been made, however, and modern stations have thermal efficiencies greater than 30 per cent, which is much higher than that of many other kinds of energy-converting plant. However, an efficient station is an expensive luxury if it is frequently out of service, and for this reason an important part of the Authority's research is devoted to the improvement of reliability or 'availability'. Boiler plant has sometimes to be taken out of service as a result of deposits which build up on the fire side of the heating surfaces to such an extent that the gas passages are blocked and the boiler has to be shut down and cleaned. The rate at which the deposits form depends on the combustion conditions in the furnace and on the presence of certain elements, such as sodium, potassium, sulphur and phosphorus in the coal. By studying such factors, methods of improving the availability of boiler plant are being continually developed. For example, at one station modifications were made which enabled the boilers to steam for 3,000-4,000 hr. instead of 500 hr. An improvement in boiler output was also obtained. Furthermore, at another station the availability of a 525,000 lb./hr. slag-tap boiler was increased from 400 hr. to one year by selecting the fuel on the basis of research into the constituents of coal responsible for fouling.

Internal corrosion is another major problem of boiler plant, and research is also in progress on the conditions inside the boiler tubes. This problem is being tackled by studying statistical data from boilers in service, and also by investigating the corrosion of boiler tubes at high temperatures and pressures in the laboratory.

In modern boiler plant, the coal is ground to a fine powder and the resulting 'fly-ash' consists of very small particles which would cause a nuisance if allowed to escape from the chimney in large quantities. Research is therefore being carried out on grit-collecting devices, and in particular, on electrostatic precipitators. For this work two pilot electrostatic precipitators have been built, so that the behaviour of different kinds of dust can be studied under

various conditions of voltage and current. This work is leading to a better understanding of the mechanism of electrostatic precipitation and should ultimately provide more efficient and more economical methods of dust collection. Even at the present time, precipitators installed at modern power stations are removing 98 per cent of the dust from the flue gases. The size of the dust particles, their density, and in particular their free-falling speed in air, are important factors in the collection and dispersal of the dust; accordingly, apparatus has been developed for grading dust samples in terms of these factors. Having collected the fly-ash, the problem of its disposal or, if possible, utilization remains, and research is in progress in several laboratories on uses of fly-ash for making bricks or building blocks, as a partial replacement for cement in concrete, a light-weight aggregate, or a filler for asphalt roads.

A power station of moderate size (200,000 kW.) requires 10 million gallons of cooling water per hour; it is not surprising that an operational requirement of this magnitude leads to some problems and provides scope for research. An experimental cooling tower has been built for research on water cooling, and work carried out with this apparatus has led to improved methods of calculating cooling-tower performance, and also to the development of a successful device for preventing the precipitation of moisture in the vicinity of cooling towers. In the laboratory, work is in progress on heat transfer in condensers and on the effect of surface films on the condenser tubes.

The inherent limitations in the steam cycle have already been mentioned, and scientists have for more than a century been looking for fundamentally more efficient energy-converting processes—in particular, they have been attracted by the possibility of turning the chemical energy of a fuel directly into electricity by means of a 'fuel cell'. It is clear that formidable difficulties must be overcome before a practical fuel cell on a sufficiently large scale to make a useful contribution to the electricity supply of Great Britain can be realized. Nevertheless, the Authority feels that it is worth while to sponsor research in universities and other organizations on various types of fuel cell. Even if the main object is not achieved, the by-products of such a research often justify the effort.

The present national peak load is about 17 million kW. and is still increasing at an average rate of about 7 per cent per year. Plans are already being put into operation to supply a peak load of 30 million kW. Coal is becoming more difficult to mine, and the hydro-electric resources of Britain can supply only a few per cent of our requirements. It is clear that the only practicable alternative to the chemical energy of coal is nuclear energy, and the Authority has therefore been working in collaboration with the Atomic Energy Research Establishment (now the Atomic Energy Authority) for some time in order to foster the development of nuclear power stations. The stations envisaged at present will use the heat produced by fission to generate steam for a conventional power station; but here again the possibility of converting nuclear or atomic energy directly to electrical energy should not be overlooked.

It is seldom that the load centres are geographically close to the sources of energy such as coal-fields or waterfalls. Furthermore, considerable economies in spare plant can be made by interconnecting generating stations. For both these reasons it is

necessary to transmit electrical energy over long distances by means of high-voltage transmission lines. Transmission lines are now operating in Britain at 275,000 volts—such a line can transmit 300,000 kW. over a distance of 200 miles at an efficiency of 95 per cent. Although electrical power transmission practice has reached a high standard, there still remains scope for research with the objects of increasing reliability and reducing cost. At these high voltages, corona discharges may occur on the surface of the conductor as a result of the high electrical stress; this causes a loss of power, the amount of the loss depending on the size of the line conductor and on the weather. Research on corona and other high-voltage problems is carried out on an experimental transmission line at Leatherhead which can be operated at voltages up to 400,000.

The insulation of high-voltage transmission lines presents many problems, particularly in industrial or coastal districts where moist deposits on the surface of the insulators may cause electrical breakdown. Research on the behaviour of insulators under such conditions has been carried out at the Croydon Testing Station for many years. This work has led to a better understanding of the mechanism of insulator breakdown and to the development of improved insulators.

Other aspects of electrical insulation are also of great importance, and work is in progress on insulating materials for switchgear, transformers and cables, again with the objects of improving reliability and reducing cost. Better methods of testing insulation are being developed in the laboratory and applied in service; in this way many serious breakdowns are prevented by detecting and replacing faulty insulation at an early stage.

Research is also in progress on insulating liquids, such as the mineral oil used in transformers and switchgear. The efficacy of anti-oxidants in prolonging the life of the oil is being studied, both in the laboratory and in service.

Lightning is one of the commonest causes of breakdown of overhead transmission systems, and electricity supply authorities in many countries have fostered research on methods of preventing breakdown due to lightning. This research is carried out in co-operation with many organizations in Britain and overseas, and also in the Authority's laboratories, where a 1.4 million volt surge generator is used to investigate surge protective devices and the ability of equipment to withstand high-voltage surges.

Overhead lines are exposed to all weather conditions and are expected to have a life of at least twenty years. It is important, therefore, that corrosion should be prevented so far as possible and, with this in mind, samples of the steel-cored aluminium conductors of the British Grid transmission system have been examined in the laboratory at intervals during the past twenty years. This work has shown that there is some deterioration due to corrosion, particularly in industrial and coastal areas. The causes of various types of corrosion have been elucidated and methods developed of preventing corrosion on new lines by impregnating and coating the conductors with a suitable grease.

As an example of research on methods of utilization, the investigations which are being made on district heating, heat pumps and electrical space-heating may be mentioned. In particular, several interesting in-

stallations with electrically warmed floors have been equipped with instruments which will give a detailed record of the weather conditions, the temperature inside the building and the electricity consumption. In this way, objective data will be obtained on the economics of this method of heating, which has the great advantage of making use of the heat-storage capacity of the floor and also of saving the wall space which would otherwise be required for radiators.

OBITUARIES

Prof. D. T. Barry

PROF. DAVID THOMAS BARRY, emeritus professor of physiology in University College, Cork, was born at Ballyanihan, about thirty miles north of Cork city, in the year 1870. He studied at Queen's College, Cork, graduating M.B. (R.U.I.) in 1894. He first practised in Birkenhead as assistant to an Irish doctor, Dr. Browne, and later on his own. He continued study at the University of Liverpool, where he found physiology of increasing interest. After some years, he handed over his practice to a younger brother and went to London, where he was associated with Starling. Later in Germany he worked with Waldeyer and Kopsch. Barry obtained the M.D. (R.U.I.) in 1903, the diploma in public health (Liverpool) in 1904, and the fellowship of the Royal College of Surgeons (England) in 1907. The same year, on the invitation of the late Prof. Windle, he accepted the chair of physiology at Cork—a post he held for thirty-four years. Before his appointment, physiology was taught as a side-line of anatomy. Barry soon changed its status in the College curriculum. New laboratories were erected and physiology became a separate department which eventually embraced histology and biochemistry.

Barry directed the Physiology Department in Cork, spending about seven months of the year there and the remainder in Paris. His work interested Dr. A. Chauchard, of the Laboratoires Maritimes de Dinard. Through this friendship, Barry made many contacts. He worked with Gley (Collège de France), Richet (École de Médecine) and Lapicque (Faculté des Sciences, Sorbonne). He also worked at the Institut Marey, Boulogne-sur-Seine. The French Government awarded him the title of Chevalier de la Légion d'Honneur in 1929. In Paris he made the acquaintance of a French lady—Miss Yvonne Boriet—daughter of a French architect and herself a distinguished artist; their marriage influenced his career, as he continued to share his time between Cork and Paris.

Barry's researches were extensive. His publications are mainly connected with cardiac perfusion and related topics, and he was a pioneer in cardiography. Most of his communications are in the *Journal of Physiology*, *Lancet*, *American Journal of Physiology*, *Archives Internationales de Pharmacodynamie*, *Comptes rendus de la Société de Biologie* and the *Irish Journal of Medical Science*.

At Cork I found Barry a delightful colleague, and his help was always freely given. I was fortunate to co-operate with him in a research on the absorption of polysaccharides obtained from the breakdown of glycogen, published in the *Bulletin de la Société Philomatique de Paris*, 1932. A colleague described Barry years ago in these words: "Superbly endowed with degrees, he was a source of inspiration to his

students. To hear D. T. Barry talk about the central nervous system, to watch him draw cross-sections of the brain and cord at different levels, to see him doing heart-lung perfusions, demonstrating the electrocardiograph and illustrating the action of curare—in 1917—was to be given a pre-view of the influence of applied physiology on the clinical practice of the nineteen-thirties and forties”.

Outside academic life, Barry had other interests. He played chess and bridge—some golf also, but found it too time-wasting for him; so he kept himself fit even in his advancing years by a vigorous, daily half-hour game of squash.

Since retirement, Barry had lived in London, where he died on April 15. He is survived by his widow (who still resides in London) and two sons, both in the medical profession: Claude (called after Claude Barnard, who deeply influenced Barry) in Edinburgh, and René in London. Barry's only daughter died in childhood.

Barry will long be remembered in Cork, where the Physiology Department is a monument to his ability and unselfish work for research. Many of his students now have distinguished positions, and all can look back on him as a very fine teacher and a valued friend.

JOSEPH REILLY

Prof. Gwyn Williams

PROF. GWYN WILLIAMS, professor of chemistry in the University of London (Royal Holloway College), died suddenly in hospital on April 6, at the age of fifty and at the height of his scientific activity.

Born on November 27, 1904, he was the only son of the late J. W. Williams, of Cae Ffynnon, Llandudno Junction, North Wales. He was educated at University College School and later became a student under Prof. K. J. P. Orton at University College, Bangor. After graduation, he was at St. John's College, Cambridge, as a Strathcona research student for two years, returning to Bangor in 1929 as a Fellow of the University of Wales. For a further five years from 1931 he worked in Cambridge on independent research in the Departments of Colloid Science and of Physical Chemistry. Later he spent some months

in the research laboratory of the Eastman Kodak Co. at Rochester, U.S.A.

It was not until 1939, at the age of thirty-four, that he took up academic teaching as assistant lecturer at King's College, London—then evacuated to Bristol. He was soon, however, given a more responsible position, and in 1946 he was appointed to the chair of chemistry at the Royal Holloway College, University of London. Since that time his department has thrived under his guidance and has become an active centre of research. He succeeded in obtaining a new building with greatly increased accommodation which was completed in 1951.

Dr. Williams's scientific work was concerned with the kinetics and mechanism of various chemical reactions, starting with studies of the chlorination of anilides under Orton and Soper and, at Cambridge, including the addition of bromine to olefins and the related problem of the catalysed polymerization of styrene, which he was still studying in recent years.

During the war years at Bristol, he joined with other members of the King's College staff in work on T.N.T. production for the Ministry of Supply, and this led to detailed kinetic studies of nitration in sulphuric acid. Williams took a prominent part in this work, which demonstrated the importance of the nitronium ion as the active agent in such nitrations. In recent years he had extended this study of nitrations very considerably, and had made use of Hammett's acidity function and of various triaryl-carbinol indicators in interpreting the results. The reversible nitration of guanidine and the esterification of alcohols by nitric and sulphuric acids were also examined in detail.

Prof. Williams served his College as a member of its Council and its Finance Committee; he was for a long period secretary of the Board of Studies in Chemistry of the University of London and latterly a member of the Senate. He also took a keen interest in Coleg Harlech, of which he was honorary treasurer. He was a chess player and a member of the Alpine Club, having climbed a great deal in Wales and Switzerland. He was an unassuming man, an assiduous worker and a wise and staunch friend. It is a tragedy that his work should have been cut short so abruptly.

NEWS and VIEWS

Botany at Cardiff:

Prof. R. C. McLean

PROF. R. C. McLEAN is retiring at the end of the present session from the chair of botany in the University College of South Wales and Monmouthshire (Cardiff). A pupil of F. W. Oliver at University College, London, he worked on fossil plants with Sir Albert Seward at the Cambridge Botany School, pioneered in the ecology of tropical rain forest while attached to the botanical gardens at Rio de Janeiro (then directed by J. C. Willis) and later taught for some years at University College, Reading. During the First World War he served as a medical bacteriologist. In 1919 he was appointed to the chair of botany in Cardiff, and the thirty-six years of his tenure of office at Cardiff have seen his Department increase greatly in size and importance. A sub-department of bacteriology has been formed, a cinematographic production unit has been set up, a new physiological laboratory has been opened, and a botanic garden has been established on the outskirts

of Cardiff; and but for the Second World War, the Department would have moved into the new building which has been designed under Prof. McLean's direction and will soon arise in Cathays Park. He is noted for his encyclopaedic knowledge and wide sympathies, and for the lucidity of his exposition, and he has undoubtedly had a great influence on the teaching of botany not only in Wales but also far beyond. Prof. McLean's lifelong devotion to outdoor studies marked him out to be the one botanist to be appointed both to the Nature Conservancy and to the National Parks Commission when those two bodies were first set up. During the inter-war period Prof. McLean visited several countries in Europe in connexion with work of the International Association of University Professors and was president of the Association in 1953; he had previously (in 1940) been president of the Association of University Teachers. He has recently toured the world in order to visit national parks in overseas countries and to study their

Administration. He hopes during his retirement to complete a monumental text-book, the first volume of which has already appeared, and to pursue further the study of botany in other lands.

• Prof. G. F. Asprey

PROF. G. F. ASPREY, who is to succeed Prof. R. C. McLean, has been professor of botany in the University College of the West Indies since 1948. Prof. Asprey is forty-six years of age, and is a graduate of the University of Birmingham, where he specialized in the field of plant physiology. Afterwards he joined the staff of the University of Glasgow and held there a Carnegie fellowship during 1934-37, and was appointed lecturer in botany. During almost the whole of the War period he served with the Royal Electrical and Mechanical Engineers, in charge of the maintenance of radar equipment in the field. Latterly, he went to the Army Formation College at Stourport, where he was head of the biology section. After a short period back in Glasgow, he went in 1947 to the University of Aberdeen as lecturer in plant physiology, and from there the following year to Jamaica. In the West Indies he was faced with the task of planning and building up an entirely new department in which active teaching had to begin almost immediately. It is not hard to understand the difficulties involved in such a position; but the new professor was also called upon to serve as dean of the Science Faculty and as a member or chairman of numerous administrative committees and, for some months, as acting principal of the College. He leaves his Department well equipped and actively engaged in research in plant physiology, ecology and pathology. Prof. Asprey's primary interest has been in physiology; but he has added to this, in later years, ecological, taxonomic and economic studies on the West Indies vegetation particularly, and extensive work on the medicinal plants of Jamaica. He therefore takes to the University of Wales a breadth of experience and interests which should be of great benefit in his new surroundings.

Safety in Mines Research Establishment:

Mr. H. T. Ramsay

MR. H. T. RAMSAY has been appointed director of the Safety in Mines Research Establishment of the Ministry of Fuel and Power. He succeeds Mr. A. H. A. Wynn, who resigned on his appointment to membership of the National Coal Board. Mr. Ramsay was born in 1907 and graduated from the University of London in 1932. For much of his career he served under Sir Clifford Patterson at the Research Laboratories of the General Electric Company, working on the application of discharges in gases to high-voltage rectification and related projects. In 1939 this work was found to have applications to radar, and his group worked on these problems throughout the War. In 1944 he was appointed to the leading staff of the laboratories and in 1948 he left the General Electric Company to join the Armaments Department of the Royal Aircraft Establishment, where he worked on problems of fighter armament. In 1949 Mr. Ramsay moved to guided missile development, where he led a group studying associated analytical and electro-mechanical problems. Early in 1953 he went to the headquarters of the Ministry of Supply to supervise a group of major industrial projects associated with this work. In 1954 he joined the Ministry of Fuel and Power and was appointed to the Safety in Mines Research Establishment.

• Element 101: Mendelevium

At a recent meeting of the American Physical Society, reported in *The Observer* of May 1 and *The Times* of May 2, an announcement was made of the preparation of yet another new element, namely, element 101. The credit for this latest achievement in nuclear science goes again to Prof. G. T. Seaborg and his collaborators at the University of California, Berkeley. Very few details about the new element are as yet available. It has been produced by bombardments of lighter elements in the cyclotron, and only a few atoms of it have been observed; nevertheless, the power of the methods used by the Berkeley team is such that identification can be regarded as certain. Although new names are still not forthcoming for elements 99 and 100, which were reported first more than a year ago, it is interesting to see that the name proposed for element 101 is 'mendelevium', presumably with symbol Me. This is a striking tribute to the Russian founder of the modern Periodic System of the elements, and implies that the chemical properties of the element agree, so far as they have been studied, with what is to be expected for an analogue of thulium. That the very heaviest elements should show rare-earth-like properties is now, of course, firmly established. One looks forward to the completion of this group of elements, at element 103; the investigation of element 104, if it ever becomes possible, will indeed constitute one of the most rigorous tests of modern conceptions of the electronic structure of the elements.

Maintenance Rates for State Scholars

DETAILS of the new maintenance rates for students at universities, announced by the Minister of Education, Sir David Eccles, in the House of Commons on April 26, have been published as Ministry Circular 285 and Administrative Memorandum No. 502 and sent to local education authorities. The arrangements are intended in the first place for State scholars and other holders of Ministry awards; but the Circular urges on all local education authorities the desirability that all students who attend a particular university with awards from public sources should receive grants at the same rates and on the same basis of assessment, and that accordingly the proposed arrangements should be adopted as soon as possible by all local education authorities. The new rates for board and lodging during term-time, which represent an increase of about 10 per cent and include an allowance for travelling expenses of £10-5, range from £283 to £225 for resident students and £171 (London) or £156 (elsewhere) for those living at home. The normal rate of vacation allowances will continue to be in the range £25-20; but the higher allowances for those in special need have been increased to £47 10s.-£38 10s.; the additional rate paid to students for an approved course of study away from home during vacation has also been increased to £3 10s. Students will now be allowed to retain prizes and awards of merit in the form of single payments up to £100 in any one year, and the annual honorarium paid to State scholars who do not qualify for assistance or hold any other award will be raised to £50.

In assessing parental contributions towards the cost of university education of State scholars, the deduction allowed from gross income for each wholly dependent child (other than the scholar) will be increased to £150, as will the maximum allowance for educational expenses and school fees and the maximum allowed for other dependants, while the

maximum allowance for university education or professional training will be raised to £300. The income scale against which the parental contribution is read off after the appropriate deductions against gross income have been made has been adjusted so as to decrease the contributions of parents with "scale" incomes of £900 a year upwards and bring into the range of assistance some parents whose sons or daughters at present only qualify for the honorarium. Special attention is directed to the arrangement now proposed for the benefit of families where more than one member holds an award. Under this the parental contribution expected is no greater than if there were only one scholar, and the Minister proposes to make arrangements with local education authorities for a similar provision where one or more members of the scholar's family hold local education authority awards. The new income scale and allowances come into force next October.

University of Reading

THE Chancellor of the University of Reading, Viscount Templewood, on May 18 laid the foundation stone of the new Faculty of Letters building. This marks the beginning of a scheme which will ultimately result in the transfer of the whole University to Whiteknights Park, a parkland site of three hundred acres on the southern outskirts of the town. The architects are Messrs. Easton and Robertson, and the builders Messrs. Taylor Woodrow Construction, Ltd. It is hoped that the building will be fully occupied by October 1956.

Desert Locust Control Organization

THE East Africa High Commission has appointed the following Commission to investigate the Desert Locust Control Organization: Sir Francis Mudie (*chairman*), Dr. B. P. Uvarov, director of the Anti-Locust Research Centre in London, and Mr. G. B. Crichton, a member of H.M. Treasury and head of one of the branches of the Organization and Methods Division; the secretary will be Mr. A. J. Fairclough, of the Colonial Office. The terms of reference of the Commission are: "To review the present operations of the Desert Locust Control Organization with particular reference to the desirability or necessity of the present level and geographical spread of expenditure on locust control work, and to make recommendations for the future; to review the arrangements for financial control and accounting methods of the Organization, and to make recommendations".

Science and Progress in Under-developed Areas

ANOTHER seminar on science in the tropics, entitled "Science and Colonial Development", was held in the Institute of Commonwealth Studies (University of London) from January to March. The seminar comprised thirty-one members under the chairmanship of Dr. W. F. Jepson (Imperial College of Science and Technology, London), who, with Prof. G. Macdonald (London School of Hygiene and Tropical Medicine) and Dr. J. R. Raeburn (London School of Economics), organized and led the proceedings. Sessions were also led by Mr. J. Rose (Colonial Office) on administration, Prof. B. S. Platt (London School of Hygiene and Tropical Medicine) on human nutrition, Dr. A. P. Stirling (London School of Economics), social anthropologist, on social aspects of development, and Dr. H. Greene (Rothamsted Experimental Station) on soil science. The seminar provoked lively discussion on the ends and means of the scientific

worker and the administrator, some salient points being the retention of fundamental research largely in the cultural centres, and the strengthening of the life-line towards the scientist working in under-developed areas, who will seek every means to interpret scientific techniques to his colleagues in other fields, to administrators and, most of all, as a member of a team, to the peasant population. An Indian speaker referred to the possibilities of using troupes of actors to present scientific results in palatable dramatic form. This technique is familiar in Britain in army instruction by means of playlets. All were agreed on the desirability of making a wider use of district teams and of paying more heed to the results of anthropological studies before embarking on social and economic development. It is hoped to arrange a similar seminar during the academic year 1955-56.

Soviet Researches in the Arctic

THE Canadian Defence Research Board has made available a translation of a brief report of the Soviet Arctic Research Institute, under the title "New Soviet Researches, Explorations and Discoveries in the Central Arctic" (translated from *Izv. Akad. Nauk., Ser. Geog.*, 5, 3-16 (1954); by E. R. Hope (Ottawa: Defence Scientific Information Service, Defence Research Board, 1954)). The report is a broad review of the achievements of recent Soviet studies in the Arctic. This includes the discovery of a great underwater mountain range dividing the arctic basin; also new information concerning the ice cover and its drift motions. There is a qualitative description of the meteorological conditions and heat balance and, lastly, a description of the geomagnetic results including the pattern of diurnal variation of the field that occurs at high geomagnetic latitudes. The organization and logistics of Soviet arctic exploration are also briefly mentioned. The report will be of interest to geographers, oceanographers, geologists, meteorologists and geomagneticians. It presents only the major conclusions reached in the various fields of study concerning this vast region. Many would no doubt like to have access to the detailed data as well.

The University Education Department

FOLLOWING his appointment as professor of education in the University of Sheffield, Prof. W. H. G. Armytage delivered an inaugural lecture on the role of an education department in a modern university. After describing the evolution of the education department, Armytage suggests that its present role is "to afford a little breathing space of one year to all intending teachers, in which we try and help them put together something that has, in many cases, been progressively taken apart and broken down into its constituent elements. We hope in this year that students can learn something about their knowledge, and, in doing so, become the kind of teacher needed in the twentieth century". Copies of this interesting and wide-ranging lecture can be obtained from the Registrar, University, Sheffield 10.

Investigations of Flower Colour

IN biochemical and genetical investigations of flower colour, and using the method of paper chromatography, Tōru Endō (*Jap. J. Bot.*, 14, 2, 187; 1954) has carried out an analytical study of the inter-relationships of various pigments in their constituents underlying the flower colour in *Viola*

tricolor. The definitive identification of the individual pigments is deferred. Some ten varieties of the Swiss giant pansy were used, their propagation being by sib-mating. It was ascertained that two flavones, five anthocyanins and five carotenoids were involved in producing the characteristic floral colorations in these varieties. These pigment constituents, in varying proportions and intensities, determine the phenomena of flower colour. The author concludes that pigments of the same kind tend to occur in groups, and this has enabled him to offer an interpretation of the mutual relationships among the varieties investigated.

Engineering Research in India

THE Board of Engineering Research, recently set up by the Council of Scientific and Industrial Research, India, has as a first step caused a survey to be made of the engineering research in progress in India and of the facilities that exist; this survey has been published by the Council under the title "Engineering Research in India", by V. Cadambe (pp. 144; New Delhi, 1954). The compiler has cast his net widely, and his review covers activities ranging from aviation to architecture that are to be found in government institutions, educational establishments and industry. Standards of skill and knowledge are known to differ widely; but only in the section on applied mechanics is the reader helped by a list of published papers to arrive at a definite understanding of what has been actually accomplished during the past few years. Recommendations covering the entire field are put forward in detail.

Society for the Bibliography of Natural History

THE annual general meeting of the Society for the Bibliography of Natural History was held at the British Museum (Natural History), London, S.W.7, on April 27. Mr. C. Kirke Swann addressed the meeting on natural history books from a bookseller's point of view. The second part of the third volume of the Society's *Journal* was issued in March 1955, containing eight articles, of which one is a select list of bibliographical reference works in zoology. The following have been elected as officers: *President*, J. Ramsbottom; *Honorary Secretary and Treasurer*, A. C. Townsend (British Museum (Natural History), London, S.W.7); *Committee*, A. G. Davis, W. N. Edwards, F. C. Fraser, F. J. Griffin, W. T. Stearn and C. Kirke Swann.

Brazilian Society for the Progress of Science: Annual Meeting

THE sixth annual meeting of the Brazilian Society for the Progress of Science (Sociedade Brasileira para o Progresso da Ciência) was held during November 8-13 at the Faculty of Medicine in Ribeirão Preto, a rapidly growing coffee centre in the interior of the State of São Paulo. The decision to hold the meeting there reflects a deliberate policy aimed at the 'cultural penetration' of the interior of Brazil. The president for the year was Prof. Lauro Travassos, a well-known Brazilian zoologist, and four hundred and twenty scientific workers and others enrolled for the meeting. A hundred and one papers were read at the fifteen sessions, and the great majority of these were devoted to biological subjects. In addition, there were symposia on science and food production, chromatography, venomous animals, and the chemotherapy of tuberculosis; a colloquium on experimental and theoretical physics; and popular lectures and film-

shows. Lectures given at the inaugural and closing sessions centred mainly around the problem of financial aid for science, and the Governor of São Paulo State spoke in support of the proposal that $\frac{1}{2}$ per cent of the income of the State should be devoted to scientific research; this would provide about £600,000 a year for research in the State of São Paulo. A number of scientific workers from abroad attended the sessions, including Prof. Robert Stämpfli (University of the Saar) and a representative of the British Council; local newspapers took the opportunity of giving publicity to the meeting in Oxford of the British Association. The next meeting of the Society will be held at Recife during June/July.

Announcements

CAPTAIN KENNETH ST. BARBE COLLINS has been appointed hydrographer of the Navy in succession to Vice-Admiral Sir Archibald Day, who has held this appointment for five years.

PROF. JAMES KENDALL will deliver the Leonard Dobbin Memorial Lecture on "Michael Faraday" on June 6 at 4.30 p.m.; this will be the first Alembic Club Lecture to be delivered under the auspices of the Royal Society of Edinburgh.

DR. N. H. CHAMBERLAIN, senior lecturer in rayon technology in the Department of Textile Industries, University of Leeds, has been awarded the Warner Memorial Medal of the Textile Institute in recognition of outstanding work in textile science and technology, and particularly for work published in the *Journal of the Textile Institute*.

THE second congress of the International Diabetes Federation will be held in Cambridge during July 4-8. The congress will cover the problems of laymen, medical practitioners and scientific workers; thus some sessions will discuss social problems (national and international) where the emphasis will be more on the medical side, some will be for laymen only, covering social problems of a purely welfare nature, and others will deal with clinical and scientific matters. The languages of the congress will be English and French. Further information can be obtained from the organizing secretary of the congress at 152 Harley Street, London, W.1.

THE Summer Meeting of the Physical Society will be held in the Lecture Theatre of the George Holt Physics Laboratory, University of Liverpool, during July 5-6, the subject of the meeting being "High-Energy Nuclear Physics". Contributions are expected from the Atomic Energy Research Establishment, Harwell; University of Birmingham; University of Glasgow; University of Liverpool; University College, London; University of Oxford; and University of Rochester, New York. Accommodation can be arranged in Derby Hall Hostel, North Mossley Hill Road, Liverpool 18, if application forms are sent there before June 16. The meeting is open to all on application to the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

In the account of the activities of the Commonwealth Fund, New York, published in *Nature* of April 23, p. 716, two mistakes have occurred in the last paragraph. The appropriations should read: 100,000 dollars for advanced fellowships in medicine and allied fields, and 685,890 dollars for the two-year budget of the Division of Education, the name of which has recently been changed to Division of International Fellowships.

SOILLESS CULTIVATION OF CROPS IN INDIA

By J. W. E. H. SHOLTO DOUGLAS

Officer-in-Charge, Hydroponic Research, Ministry of Food, India

WITH the object of evolving less-complicated methods of soilless cultivation, research studies in hydroponics were commenced in 1946 at the Government of Bengal's experimental station at Kalimpong in the Darjeeling district of India. The object was to perfect a novel system of which practicability and simplicity would be the keynotes, suitable for use by the layman. It was hoped that eventually hydroponics would be able to make the large cities self-supporting in all vegetables, and bring barren regions under cultivation.

The results achieved, after a period of nine years experimental work and extension activity, are of some interest. Not only in India, but also in other countries, the Bengal methods of soilless culture have made good progress. Inexpensive to instal, simple to maintain and economical to operate, the technique has reduced equipment to a minimum, and made full use of indigenous materials, while straightforward rules have been framed to guide the operator.

Hydroponic troughs have been laid down at the most unpromising sites. With the Bengal system, beds may be made from almost anything except galvanized iron, but if this has to be used it should first be given a coating of asphalt enamel. Wood, concrete, felting, bricks, mud plaster, iron and steel, asbestos sheets, and puddled alkali-treated clay are all satisfactory. The best width for troughs is one yard, and any convenient length. The sides of a hydroponic bed should be about eight inches in height. Drainage is provided by semi-porous walls and small holes around the bases, with guttering to carry off seepage. The bed is filled to a depth of eight inches with a coarse inert aggregate, preferably a mixture of five parts of stone chips, gravel, broken bricks, or leached cinders, of $\frac{1}{8}$ - $\frac{1}{4}$ in. grade, and two parts of sand or rock dust. This is the growing medium. Water is introduced to this aggregate by a system of inlet pipes. An ideal degree of saturation has to be maintained: the best example is to say it should resemble a damp sponge just lightly wrung out. Excessive dryness or water-logging has to be avoided.

The nutrients may be applied in more than one way. A balanced formula made up of fertilizer grade salts, and applied dry by spreading between the rows of growing crops, at the rate of two ounces per one square yard of trough surface space every ten days, is the most popular method. Nutrients applied dry must be immediately watered in with a light spray of water. Resort may also be had to amberlites, or synthetic resins on which are adsorbed cations and anions. These will supply the plants with the necessary nutrients throughout the whole growing season, only one application being called for.

In India, the following formula, made up from fertilizer-grade salts, has given good results:

Fertilizer	
Nitrate of soda	14 oz.
or	
Ammonium sulphate	12 "
Superphosphate	6½ "
Calcium sulphate	3 "
Potassium sulphate	5 "
Magnesium sulphate	4 "
Trace elements	½ dram

The minor elements mixture consists of:

Zinc sulphate	3 0 dram
Manganese chloride	9 0 "
Boric acid powder	7 0 "
Copper sulphate	3 0 "
Iron sulphate	10 0 "
	32 0 dram

Application rate for this nutrient mixture is 1½-2 oz. per square yard of trough surface space every week or ten days, as required.

The quantities of synthetic resins used per one square yard of trough space to last for six months are as follows:

Amberlite	
Ca++	37 oz.
Mg++	18 "
H ₂ PO ₄ -	2½ "
SO ₄ =	5 "
H ₂ BO ₃ -	1 "
Fe++	1 dram
Mn++	½ "

Potassium nitrate is applied two or three times weekly in the irrigation water at the rate of 20 oz. to 100 gallons of water. Other elements are present as impurities in the media.

Glass matrices, of the following composition (per cent), are now being tested with the object of substituting them for the trace-element mixture hitherto used in the fertilizer grade salt formulæ: boron, 2.5; manganese, 4.4; iron, 11.0; molybdenum, 0.22; copper, 0.44; and zinc, 4.4. Rate of application is 1 lb. to 400 square feet of surface area per season.

The general aim has been to maintain a balance of the nutrient elements within the following framework, whatever the vehicle used for supplying them may be:

Element	p.p.m.
Nitrogen	200-400
Potassium	100-200
Phosphorus	80-100
Magnesium	50-100
Calcium	300-500
Iron	2-10
Manganese	0.5-5
Boron	0.5-5
Copper	0.5
Zinc	1 0

A deficiency of any particular element has been found to produce symptoms approximating to those listed below:

Characteristic symptoms	Indicating a lack of
Plant light green in colour, slow growth, general necrosis of tissue, poor development, stunted and yellowish leaves	Nitrogen
Abnormally dark green plants, purple or reddish pigmentation, dull appearance	Phosphorus
Crinkled and curled leaves, mottling in places with chlorosis at tips, brown and scorched foliage	Potassium
Dark, stunted appearance, death and blackening of terminal buds, shortened roots with necrotic apices	Calcium
Chlorosis between leaf veins, spotting first white, later turning to brown	Magnesium
Severe interveinal chlorosis, followed by burning, veins remain green	Iron
Small brown necrotic spotting or checkering following chlorosis	Manganese
Veins turning yellow with dead areas of a purple colour forming at leaf bases. Entire plant yellowish	Sulphur
Distortion of leaves, chlorosis beginning at bases and margins, gummy or corky deposits in fleshy organs, hollowing, brittle stems	Boron
Irregular chlorotic spotting between veins of older leaves, necrosis rapid with defoliation. Die-back stunting	Zinc
Pronounced top wilting and lack of turgor, some chlorosis	Copper

pH values of the moisture present in hydroponic beds operated under the Bengal system should be approximate to readings between 6.0 and 6.5. These are the most suitable reactions for all general crops, though experience has indicated that for some plants, such as potatoes, a lower pH, such as 5.0, is desirable. However, for practical work it is necessary to lay down a figure which gives reasonable results in most circumstances. BDH Universal is a satisfactory indicator for use by the relatively unskilled person. A variation of a few grams in the salts applied in bulk under practical conditions is immaterial. In India, care is always taken to impress upon growers that the rules laid down for operating techniques must be strictly followed, since the safety margin is narrow. Very often tablets containing the complete formula, or packeted ready-mixed salts, are issued to the public.

In Bengal, at the experimental sectors at Kalimpong, the salinity of the water supply is between 120 and 130 parts per million.

Overhead shading of mats is provided on canopies eight feet high, so as to admit morning and evening light, but to exclude the scorching rays of the noon-day sun. Evaporation is also checked by these devices. In colder climates, such as that of the United Kingdom, cloches could easily be fitted to provide protection in winter.

Results. A few of the trials undertaken in Bengal are reproduced to illustrate what has been achieved:

Tomatoes: Plots of Suttons 'Best of All' have given averages of 22 lb. of fruit per plant, excluding 'chats', as against soil control yields of 8-10 lb. Acreage averages come to 150 tons. Growth period is about 170 days, with picking beginning on the ninetieth day after sowing.

Lettuce: Several varieties, including 'New York', 'Cos', 'Wayhead', gave crops of between 30 and 50 lb. per 100 square feet, with a growing time of 35 days.

Maize: 'Yellow Flat' maize has produced yields of 6,000 lb. of grain per acre, against the usual crop in soil of 2,000 lb.

French Beans: Dwarf 'Canadian Wonder' produced 1 lb. per square foot of edible pods 40 days from sowing. Picking continued for a month.

Rice: 8,000 lb. of grain per acre.

Potatoes: Averages of early new varieties ('Darjeeling Red') gave a tonnage of 65 to the acre, and maincrops 90 tons.

Onion: Variety 'Baluchistan', yield amounted to 160 lb. from each 200 square feet of bed.

Beetroot: $\frac{1}{2}$ lb. to the square foot in soilless beds.

Broad Bean: A yield of $\frac{1}{2}$ lb. to the square foot.

The question of water consumption has also received attention. It is of considerable importance. Obviously hard and fast rules cannot be laid down, since in different regions the rate will vary. In North Bengal it needs 200 gallons two or three times a week during the dry season, with maximum and minimum daily temperatures of 80° F. and 50° F., to keep suitably moist a trough of one thousand square feet. Less is required in colder places, and more in very hot localities, unless the climate is humid. However, hydroponics under the Bengal system compares favourably with soil, since it is obviously better to run the available water supply into controlled soilless beds than to dissipate it wastefully over the fields. At no time should 'ground' temperature, that is, surface heat of the soilless beds, be allowed to exceed 90° F., otherwise transpiration will pass the safety limit. This problem has been solved in Bengal by using the overhead canopies.

A device for automatically distilling fresh water from brine for use in hydroponics has been tested successfully. In India, the apparatus, which consists of a dome of metal covering water trays surrounding a central column of calcium chloride, has given good results. It works by means of the sun's heat, evaporating the trapped water into vapour in the

day-time, which then condenses at night with the fall in temperature. The salt is left in the trays. The device is portable.

Further trials are proceeding at the Indian units with additional aids to cultivation, such as phosphate pebble rock, and crushed rock phosphates, activated sludge powders, wood ashes, effluents, and other materials.

A Hydroponic Information Centre has been opened at P.O. Box 31, Bombay, India, to provide advice and literature on the method.

REFERENCES

- Hydroponics (Soilless Cultivation). Bulletin No. 1. Issued by Hydroponic Research Centre, Government of West Bengal Experimental Farm, Kalimpong, Darjeeling, India (1947).
 Sholto Douglas, J. W. E. H., "Hydroponics: The Bengal System" (University Press, Oxford, 1952).
 "Instructions for Preparation of Non-erodible Mud Plaster". Director of Irrigation Research, Department of Irrigation, Lahore, Punjab, West Pakistan.

ELECTRONICS IN THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

By DR. D. GABOR

IN recent years, the shortage of physicists and engineers trained for the development and production of valves and electronic devices of all kinds has become alarming. The British valve industry is at present producing valves at the rate of 60 million a year, and television tubes at the rate of 1.8 million. Not only future expansion but even the maintenance of the present volume of production will be jeopardized unless research, development and modern production methods keep step with international competition, and this depends in the first place on the supply of trained specialists. Recognizing this situation, two years ago the British Radio Valve Manufacturers Association approached Prof. Willis Jackson, then head of the Electrical Engineering Department in the Imperial College of Science and Technology, London, with an offer of support for a full-session postgraduate course in applied electron physics. With the aid of a generous special grant by the University Grants Committee, the Electronics Laboratory of the College was completely re-equipped, and the course opened for the session 1953-54. It now forms a permanent part of the general postgraduate course in electronics and communications which was first organized in the College in 1949.

The curriculum is intended to follow, more or less, the course of a vacuum device from research through development to production. All electronic vacuum devices are based on the dynamics of the free electron in electromagnetic fields; hence the course starts with an introduction to electron dynamics and a recapitulation of electromagnetism, immediately followed by practical exercises. The students receive their first introduction to high-vacuum techniques at a special test-bench, fitted with all types of vacuum gauges, where they can verify for themselves the laws of the flow of gases at low pressure, pumping speeds, etc. Another test bench is equipped for the verification of the basic laws of gas discharges, and a third, a large demountable vacuum tank, for the demonstration of electron optics.

As rigorous analytical methods are seldom applicable to practical problems, the main emphasis in

the teaching of electron dynamics and electromagnetism is on numerical and model methods. A large electrolytic tank is available for the rapid and accurate charting of electrostatic fields in two or three dimensions, and for certain magnetostatic fields. Electron trajectories are plotted graphically by a hand-operated tracing trolley and by other methods. In the special case of cylindrical or 'plane' electrostatic fields, a large rubber-membrane model enables the field and the electron trajectories to be obtained in one experiment, by rolling steel balls over the membrane. These methods are usually sufficient for an approximate design of the electrode shapes in valves, television tubes, electron multipliers, image tubes and other devices. For the testing and final correction of the design, demountable vacuum chambers are the most effective aids of the research and development engineer. Three large metal vacuum tanks are available, in which vacua of the order of 10^{-5} mm. mercury can be maintained while six or more mechanical adjustments are carried out from the outside without breaking the vacuum.

Once the electron-dynamical design is fixed, technological development can start, which leads ultimately to a sealed-off device, to be put in the hands of the circuit engineer. The technological equipment of the Electronics Laboratory in the Imperial College is sufficient for making up almost any type of vacuum device, and for instructing the students in most of the usual processes. The glass-blowing shop is equipped with a large horizontal glass lathe and two smaller vertical machines, with supplies of coal gas, oxygen and hydrogen for glass and quartz blowing, and with annealing ovens. Two hydrogen furnaces and a muffle oven are available for the heat treatment, in protective atmospheres, of metals for use in vacua, and a large, 30 kW. vacuum furnace is under construction for temperatures up to 3,000° K. A number of spot welders and a small atomic arc welder are provided for the assembly. The exhausting of valves up to the size of small cathode-ray tubes is done on two medium-size exhaust stands; a large stand serves for television tubes; all are supplied with high-frequency power from a large induction heater. An electroplating and cleaning plant and several stands for vacuum coating of metals complete the technological equipment.

The theoretical training of the postgraduates centres on vacuum electronics; but in view of the growing importance of semiconductor valves, they attend also a course on the physics of solids. (Laboratory equipment for germanium techniques is available.) Other items in the syllabus include electro-magnetic theory, microwave techniques and circuit theory, with exercises in the Microwave and Communications Laboratories of the Department. There is ample opportunity for attending special courses on mathematics, wave mechanics, higher circuit theory, acoustics, ultrasonics and communication theory for those specially interested.

From its inception in 1953, the lectures given in the course by the teaching staff of the Imperial College have been supplemented by special lecturers from industry. Leading specialists have been invited to give comprehensive surveys of technological topics such as ceramics, metals in vacuo and glass, and on advanced electronic topics such as microwave valves; also on engineering economics and quality control, which are of special interest for future production engineers.

The postgraduate course of the College in applied electron physics is open to applicants holding the B.Sc. or higher degrees of British, Commonwealth or equivalent universities, but in special cases also to holders of Higher National Certificates, if the applicants have had previous experience in electronic research, development or production, and if in an interview they are judged likely to profit from the course.

In the third term the postgraduates are given problems, usually of a practical kind, which might lead to useful results and which require independent thinking, and they are provided with experimental equipment for two to three months research or development work. Those who are successful are entitled to submit a thesis for the diploma of the Imperial College (D.I.C.). This is a unique opportunity for those who for some reason have missed the university, and whose gifts have been discovered too late, to obtain an alternative award with a recognized reputation.

The British Radio Valve Manufacturers Association is aiding this course not only by financing its running expenditures, but also by sending to it some of its engineers and physicists who, in its opinion, can profit more by broad and intensive academic instruction than by the experience which they could acquire in the same interval of time in an industrial laboratory or production department. Moreover, certain companies may be willing to subsidize the training of students who have the intention of joining industry after their postgraduate year, provided they show sufficient promise. Though the present shortage of electronic physicists and engineers makes it very desirable that entry into industry should not be much delayed, those attending this course who have shown outstanding scientific ability and interest are encouraged to do a further year or two in the Research School of the Electronics Laboratory. This will enable them to acquire the M.Sc. or Ph.D., provided they have the necessary first degree. Fully trained, hard-working specialists are indispensable for maintaining the present strong position of the British electronic industry; but only exceptional engineers and physicists can put it in the lead.

X-RAY ANALYSIS GROUP OF THE INSTITUTE OF PHYSICS

SPRING CONFERENCE

THE spring conference of the X-Ray Analysis Group of the Institute of Physics was held in the H. H. Wills Laboratory of the University of Bristol during March 30–April 1. The communications which were read by members of the Group and others covered a wide range of interests and were not restricted to any one particular aspect of X-ray crystallography. A particularly stimulating evening discourse was delivered by Prof. H. C. Longuet-Higgins, who discussed the peculiar problems posed by the structures of the hydrides of boron.

The first paper, by Prof. A. J. C. Wilson, dealt with his further investigations on the effects of various symmetry elements on intensity distribution functions. He has extended earlier studies to cover cases where molecules possessing centres of symmetry are placed in space groups containing other symmetry

elements in addition to centres of symmetry. The resulting distributions have been evaluated approximately: they are found to lie somewhere between the centric distribution (asymmetric molecules in a space group containing only a centre of symmetry) and the bicentric distribution (that is, molecules containing a symmetry centre in a space group with only a centre of symmetry). Expressions for the variance of the new distributions were given. Dr. T. H. Goodwin then described some results of applying the molecular orbital technique of wave mechanics to the calculation of bond-lengths in conjugated compounds. In the cases of a number of hydrocarbons excellent agreement was obtained between calculated bond-lengths and those observed by X-ray methods. Dr. W. Cochran and Mr. M. M. Woolfson have extended their studies of direct structure determination by calculating expressions for the probability of the correctness of sign relations for additional space groups. Their results, which are in good agreement with observations, show that in most practically important cases of reasonably complex structures the probability of obtaining correct signs directly from the observed intensities is low; no routine solution of the phase problem is as yet possible. Dr. A. Klug described new methods for the determination of absolute intensities of X-ray reflexions. In essence, the mean intensity curve is equated to the sum of the coherent and incoherent scattering at large values of $\sin\theta/\lambda$; where the course of the intensity curve is not directly observable in this region, it can often be calculated from that portion of the radial distribution function due to nearest neighbours. In the subsequent discussion it was suggested that it might be simpler to obtain the necessary information directly from powder patterns rather than to calculate it from single crystal data.

The next group of papers dealt with structure determinations. Dr. D. F. Grant and Dr. D. Rogers presented their results on the structure of hydroxydihydroeremophilone, a bicyclic sesquiterpenoid, which confirm the configuration proposed by Simonsen. This conforms to current theories of the biogenetic origin of the terpenes. The structure determination was presented as an example of the use of direct methods. The Sayre-Cochran relations proved to be of great value in the (100) projection in which the molecules are seen edgewise and in which there is much overlap of peaks, but not in the (010) projection—the plane of the molecules—since with about seventeen resolved atomic peaks there was little statistical bias in favour of the true sign. Mr. H. P. Rooksby discussed the crystal growth of barium and strontium oxides in oxide cathodes. Semi-micro beam methods were used, and the grain sizes were found to be of the order of a few microns. This technique revealed the presence at some stages of crystals several times larger than the mean size which had previously been estimated from line-broadening. In addition to crystal growth, the thermal treatment produces progressive lattice parameter changes not as yet fully explained. Considerable disturbances in the atomic arrangement are also indicated by the line-broadening which accompanies the crystal growth. Dr. J. C. Speakman had investigated the crystal structure of the acid salts of a number of monobasic organic acids. The majority of these salts, but not all, were shown to form symmetrical hydrogen bonds. Dr. H. D. Megaw and Miss C. H. Kelsey presented work on the unit cell of

tobermorite, a hydrated calcium silicate. The structure is best described by reference to an orthorhombic unit cell; systematic absences indicate that the true lattice has a and b axes along the face diagonals of the orthorhombic cell, and is probably monoclinic A -face-centred. The crystal samples studied showed a variety of stacking faults and intergrowth phenomena. Dr. G. A. Jeffrey and Dr. G. S. Parry had re-examined the structure of aluminum nitride, which was shown to differ slightly from the ideal wurtzite structure with its tetrahedral arrangement of bonds, both as regards axial ratio and u parameter. Since, in determining the crystal structure it was only necessary to adjust the latter parameter and the temperature factors, it was found possible to use powder diffraction data. Dr. R. D. Lowde described a study of neutron diffuse reflexions produced by a Type I diamond selected for showing strong 'extra' X-ray reflexions. Similar neutron effects were found which showed that the structure fault characteristic of Type I diamonds is one which affects the atomic positions and is not an exclusively electronic phenomenon. The shape of the reciprocal lattice spikes as here determined by neutron diffraction and as studied by Wooster and Hoerni by X-ray methods lends weight to a suggestion that in Type I diamonds some parts of the structure have gone some way towards graphite, so that quite large changes of atomic positions are taking place. Small changes are ruled out by the X-ray results.

The most ambitious structure determination to be reported, and, indeed, perhaps the most complicated ever carried out, was that of a nucleotide-free degradation product of vitamin B₁₂ by Miss J. Pickworth and Dr. D. Hodgkin. A three-dimensional Fourier synthesis based on the cobalt atom phases was first calculated. It indicated, together with information from similar calculations on the vitamin itself, the positions of some twenty-five atoms surrounding the cobalt atom in a porphyrin-like structure. From further Fourier syntheses, side-chains, mainly succinyl and acetyl attached to the inner porphyrin-like group, were identified and finally the positions of sixty-two atoms were calculated. The molecule contains about seventy atoms, other than hydrogen, its approximate formula being $\text{CoN}_8\text{C}_{44}\text{H}_{87}\text{O}_{18}\text{Cl}$, and although all the positions are not yet certain, the general nature of the molecule is now evident.

The remainder of the conference was devoted to apparatus and techniques. Dr. B. T. M. Willis described the use of gratings representing structures with stacking faults and of modulations of lattice parameter and scattering factor in a Lipson diffraction spectroscop. The gratings are prepared by moving a fine-grain photographic plate past a point image by means of micrometer movements: they contain at least 100×100 'atoms' and can be prepared in about one hour. Mr. E. F. Priestley showed how rapid fluorescence analysis can be carried out using photographic recording and curved lithium fluoride crystals as analysers. In order to detect fractions present to the extent of one part in ten thousand, exposure times of about half an hour are required: normally exposures of about one minute suffice. All elements heavier than potassium can be detected. In another paper he described the methods used for perfecting the monochromator technique and its application in conjunction with focusing powder diffraction cameras. Dr. W. C. Nixon gave an account of his point-source X-ray tube. Using magnetic

focusing, it has been found possible to produce a source less than one micron square on an air-cooled foil transmission target which can be loaded to a power of one watt. Thus the brightness is about 1,000 kW./mm.², as compared with an effective brightness of about 1 kW./mm.² in a normal foreshortened diffraction X-ray tube focus. The new point source has been employed principally in shadow microscopy, when a resolution of about 1000 Å. has been obtained; applications in microbeam diffraction are being studied. Dr. J. W. Jeffrey analysed modern practice in intensity estimation where insufficient attention is often paid to experimental accuracy. He described methods of grinding specimens to a spherical shape to facilitate absorption corrections; the use of some form of integrating mechanism on moving-film cameras permits the employment of a very simple densitometer. Dr. U. W. Arndt reported only moderate success in the use of radioiodine for silver estimation in photographic images; the method gives a measure of the integrated intensities of single crystal spots. In spite of a number of ingenious suggestions to obviate this, it is generally necessary to punch out each spot individually before measuring the activity. The use of emulsions considerably thicker than normal increases the sensitivity to X-rays and the reproducibility of measured intensities at the expense of much more elaborate processing requirements. Dr. R. L. Gordon discussed methods of making 'lost counts' corrections in monitored Geiger-Müller counter systems and described a direct way of measuring the form factor for a self-rectifying X-ray tube. Dr. G. S. Parry and Dr. S. C. Abrahams gave brief descriptions of the General Electric and Norelco counter diffractometers, respectively.

Dr. R. W. Cahn had used the Buerger precession camera for metallurgical problems where the orientations of very small regions had to be verified, such as in the examination of mechanical twins in molybdenum. The very low background scattering allows very weak reflexions to stand out. Mr. H. J. Goldschmidt commented on some of the problems in high-temperature powder photography: his new camera, which was sponsored by the X-Ray Analysis Group of the Institute of Physics, provides the most satisfactory solutions to date. The greatest difficulties are those of specimen mounting and of evaporation of furnace windings; periodic calibration of thermocouples is always necessary owing to vapour contamination. Dr. R. Witty reported on his studies of X-ray tube characteristics. He pointed out the advantages of d.c. operation which, for the type of stationary anode design common in demountable X-ray tubes, permits a doubling of the target loading as compared with self-rectifying operation. Similar gains are possible with rotating anodes. He gave focal spot and saturation current characteristics as a function of bias voltage. This bias is most conveniently provided from a separate bias supply as distinct from a bias resistance. Mr. P. Holroyd and Dr. D. L. Smare had studied similar phenomena in micro-focus tubes. For fixed bias resistance the anode current rises exponentially, and the focal spot diameter falls exponentially, with decrease in anode-cathode separation. Dr. A. L. MacKay described a miniature Weissenberg camera and a miniature retigraph designed to take full advantage of the properties of a micro-focus X-ray tube in the examination of very small crystals. A number of novel features are incorporated, particularly in the design of the goniometer heads.

U. W. ARNDT

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

THE South-Eastern Union of Scientific Societies held its sixtieth annual congress in Folkestone during April 14-17, under the presidency of Dr. Russell J. Reynolds. Throughout the congress an exhibition of geological, archaeological, botanical, zoological and general interest was on display at the Leas Cliff Hall, and the programme included a young naturalists' evening, when questions from children were answered by a panel of experts, and a lecture by Maxwell Knight on the habits of the cuckoo, illustrated by a film.

Dr. Russell Reynolds's presidential address to the Union was on "Cineradiography". He commenced by outlining the technique and application of his subject. Röntgen made his discovery in November 1895, and Dr. Reynolds still has a plate taken by himself by X-ray photography in 1896. Two years afterwards John Macintyre produced an X-ray cinematograph film by re-photographing on an ordinary cinematograph film a series of radiographs of a frog's leg which had been slightly moved between the exposures. Gradually the apparatus improved, tubes were more reliable and fluorescent screens gave greater luminosity. Sensitivity of film emulsion increased, and lenses of wide aperture were made. Two methods of making cineradiograph films became possible—the direct and indirect. The first utilizes the power X-rays have of affecting a sensitized photographic emulsion; in the second the rays passing through the subject strike a fluorescent screen, and the shadow cast is photographed. X-rays cannot be focused, and this limits the direct method. Difficulties with the indirect method include the weakness of the intensity of light emitted by the fluorescent screen; when this is increased, the exposure risk to the subject is also increased. Dr. Reynolds said that he began his cineradiographic experiments in 1921 using the indirect method. Later he introduced a switch which synchronized the excitation of the tube with the opening of the camera shutter, thus reducing both the exposure of the patient to risk and the strain on the tube by half. Improvements continued, and at the present time the method used is reliable and safe. The cost has been reduced and does not exceed that of a complete X-ray examination in the usual way. Modern apparatus has a specially designed transformer unit, and the X-ray tube has a double-focus cathode. The camera lenses have a wide field, the apertures being $f/0.7$ and $f/1.5$; the speed of the camera can be adjusted at will from 3 to 100 frames per second. The technique in making cineradiographic film differs little from that employed in normal radiography. Dr. Reynolds stressed the importance of the use of short coils of film that can be projected continuously, not only for the purpose of medical diagnosis, but also for training students.

The presidential address to the Archaeological Section was given by Major H. M. Rand, who spoke on "The Saxon Shore Forts of Kent". He said that historical evidence, often not contemporaneous, can be misleading and that muddy boots are sometimes better than documents. The archaeological approach is the correct one, and excavation may solve the problem of the 'lost centuries'. There is an absence

of uniformity in the forts: some are rectangular (Reculver), others oval (Pevensey), and the areas vary from five to nine acres. Occupation in some commenced in the first century and continued until the fifth; in others there is evidence of two separate periods in the second and fourth centuries. The coastline differs considerably from that of the present day, erosion and silting up, particularly of the Wansunt Channel, making the location of the forts problematical. The Kent Archaeological Society commenced excavation at Richborough in 1922, and the fifth report is now in the press. The cruciform platform is unique, and may have supported a monument to commemorate a triumph during the third century; triple defensive ditches were raised about the same time.

Dr. Maurice Burton gave the presidential address to the Zoological Section, his subject being "Art in Animals". He said that he differs from some of his colleagues in the line drawn between man and the other animals, for we may tend to trust our reason too much. There is opportunity for us all to study the difference between human and animal behaviour. The love behaviour is much the same, that of male and female sticklebacks being a case in point. Maybe, he said, the difference is one of quantity rather than of quality. Dr. Burton spoke of the beauty, to our eyes, of the shells of single-cell animals, the Foraminifera, and of the sponge called the Venus flower basket. He mentioned the ability of lower life forms to take material from outside their bodies to construct beautiful homes—the tube-making worms, caddis fly larvae and the nests of fishes and birds; the web of a spider compares favourably with the efforts of a civil engineer. The difference between man and the animals is that aesthetic appreciation has evolved man's consciousness of his art. In animals mechanical skill is highly developed. Dr. Burton then dealt with the evolution of the eye from the light-sensitive cell of the lowest organisms. The bower birds have especial skill in the construction of their elaborate houses, for they use natural pigments for colouring sticks, selecting favoured ones and burying those considered distasteful. Colour should be related to the development of the eye, and while at times its value is protective, at others it has a physiological value: it has signal values with the birds and fishes and arouses emotions. The appreciation of sounds by animals when they have no other apparent value than aesthetic was briefly mentioned by Dr. Burton, and also the question of taste.

Dr. Francis Rose, as president of the Botanical Section, spoke on "The Flora of Kent", saying that the earliest plant records are those of Turner, in 1549, dealing largely with the plants of the Dover area; the inaccessibility of the Weald prevented recording from there. The Elizabethan records were from the point of view of the herbalist; Gerard, in 1597, recorded plants still thriving in the same localities. Even during the nineteenth century transport was difficult in the Weald, thus accounting for some of the missing species in the work of Hanbury and Marshall. Dr. Rose commenced his work upon "The Flora of Kent" in 1942, and it will be published during the autumn of this year. Its sections deal with the distribution of species, the ecology, plant distribution as a whole and floral statistics. C. W. Wright chose for the presidential address to the Geological Section the subject of "Unsolved Problems in Cretaceous Stratigraphy and Palaeontology" and commenced by saying that Folkestone can be regarded as the centre of English

geology. Much work is left to be done in spite of the intensive work of Rowe, Jukes-Browne, Whitaker and the Weald Research Committee of the Geologists' Association. There are many surprises around the corner, said Mr. Wright. The beds at the base of the Albion, thought to be allied to the Lower Greensand, may be more closely related to the Gault. Although each ammonite carries its evolutionary life-history, species evolved and disappeared in such relatively short times that the gaps between the species now found causes problems which may never be solved owing to the vast amount of material denuded, so removing the required evidence. Lithographical similarity in various districts can be misleading as regards zoning, as palaeontological evidence has proved a sub-zone difference in some cases. World-wide correlation is exceedingly difficult owing to the lack of evidence, and Mr. Wright emphasized that ammonite material, however fragmentary, is needed to aid the solution of the problems.

During the congress favourable weather conditions enabled the full programme of excursions to be carried out. The archaeologists visited Wye College and Church, ancient occupation sites on the Downs, Studdfall Castle, the Roman fort of the Saxon shore and a fortified Manor House at Westhanger. The botanists and zoologists went to Westwell, Hothfield, Little Chart, Saltwood, Romney Warren, Dungeness Bird Observatory and the Folkestone Corporation greenhouses. The geologists made excursions to the Warren Defence Works, the Stour Valley near Ashford, Great Chart, Kennington, Wye and Brabourne.

The sixty-first annual congress of the Union will be held next year in Tunbridge Wells during May.

CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1954

THE forty-first annual report of the Carnegie United Kingdom Trust*, to which are appended the accounts for the year ended December 31, 1954, covers the fourth year of the present quinquennium and is concerned chiefly with the development and direction of existing schemes. Such good progress has been made with the programme for the development of local museum services that during the year the allocation of £40,000 for the five years was increased to £50,000, most of the fund being earmarked for direct grants to enable museums to improve their standards of display. In this field, the most important event of the year was the reopening of the Taunton Castle Museum after its complete re-organization. The Trust notes that the service of expert reports has continued to be of much value to the museums movement, but that a major difficulty in re-organization has been that the schemes involve the exercise of technical skill beyond the resources of the museums concerned. Grants for reorganizing displays were made during the year to the Banff Museum, Hove Museum of Art, Museum of Leathercraft, London, Torquay Natural History Society Museum, Truro Museum and the Worthing Museum and Art Gallery. During the year, five village hall

* Carnegie United Kingdom Trust. Forty-first Annual Report, 1954. Pp. viii + 43. (Dunfermline: Carnegie United Kingdom Trust, 1955.)

schemes receiving grant-aid were completed, and work began on three other schemes. The Trust welcomes the indication in the Queen's Speech on November 30 that restrictions on village hall expenditure will be eased, and it is hoped that building will be started during the next twelve months on the seven remaining schemes.

During the year, 269 new cases were referred to the Family Discussion Bureau, which also stabilized its function as a training agency. The Family Welfare Association expected to publish in February 1955 a book entitled "Social Casework in Marital Problems: Studies in the Development of a Psycho-dynamic Approach". The Trust is also specially interested in a project of the Association which seeks to provide by research some knowledge of the nature of problem families and to suggest how to deal with them, and also to provide social workers concerned with family problems with practical hints on day-to-day procedure when immediate action is demanded. Eleven Family Service Units are now operating, and the Trust's grant is supporting the development of units, the collection and assessment of research data, and,

mainly, the training of social workers in family service techniques, which is done basically by closely supervised field-work with attendance at special courses organized by universities and professional bodies.

Good progress has been made in defining the work which the National Association for Mental Health, formally inaugurated last July, should attempt in the north of England. The research council set up by the College of Teachers of the Blind, to which the Trust promised a grant of £100 a year for three years for research into the possibility of establishing standard attainment tests for children in blind schools when making selections for further education, has also started research on the design and testing of apparatus to throw light on how the blind detect obstacles and whether the art can be taught; and a grant of £400 has been made to the British Association of the Hard of Hearing for the installation of a recently developed public-address system. A new course in applied social studies at the London School of Economics and Political Science was inaugurated with twenty-five students in October.

RADIATION SENSITIVITY AND THE MITOTIC CYCLE IN *VICIA FABA*

By DR. JOHN MCLEISH

John Innes Horticultural Institution, Bayfordbury

THE sensitivity of living organisms to ionizing radiations can be assessed in terms of rapid morphological change, chromosome breakage and gene mutation. It is generally agreed that sensitivity varies not only between individuals but also between the tissues within individuals according to the genetic constitution and physiological activity of their cells. In the dividing cell, sensitivity, which is readily assessed by chromosome breakage, can be influenced by the number of chromosomes¹, their position and mobility in relation to one another² and to the phase through which the cell is passing at the time of irradiation²⁻⁴. It may also be modified by various physical⁵ and chemical⁶ agents.

Yet there have been very few demonstrations of the influencing of sensitivity by genes⁷ or by any of the visible elements comprising the chromosomes themselves⁸. In the latter case, this has been difficult to show since between closely related varieties or within single tissues there are rarely any detectable chromosomal differences which would form the basis of a comparison of radiation effect.

This difficulty can now be overcome to some extent by giving a preliminary chemical treatment to induce localized chromosome breakage. Such a treatment produces, within a single tissue, a mixed population of cells with known differences the variable response of which to a single irradiation can be studied.

In these experiments, secondary lateral roots of *Vicia faba* seedlings growing in tap water were treated with a 0.1 mM aqueous solution of maleic hydrazide for five hours. Maleic hydrazide is known to induce breakage in, or close to, heterochromatic segments⁹; and with the dose employed 83 per cent of breaks occur in and around the large segment in the nucleolar arm of the A chromosome. Thus the majority of acentric fragments carry nucleolar organizers. These become randomly distributed between

daughter cells at the completion of one mitosis. Then, by a mechanism which I have described elsewhere¹⁰, a high proportion form viable micronuclei which persist and reproduce in step with the main nuclei through consecutive mitoses. After 2-3 days, cells are present in the roots with 0.5 nucleolar organizers.

In *Vicia* roots the mean time for the mitotic cycle is of the order of 24 hr.^{11,12}. Therefore, after the maleic hydrazide treatment, when some cells had completed two mitotic cycles, an X-ray dose of 100 r. was given. Roots were then fixed 4, 6, 10, 14 and 18 hr. later (Fig. 1). But all these fixations were made 72 hr. from the start of maleic hydrazide treatment and in all cases the last 1½ hr. were occupied in pre-treatment in 0.05 per cent colchicine to facilitate scoring. Roots receiving maleic hydrazide or X-ray treatment alone were also fixed as controls. Observations were made on Feulgen squash preparations, and the total breakage (chromosome breaks *B* + chromatid breaks *B'* + minute fragments *mB''*) scored in all classes of metaphase cell. The results for cells with various numbers of nucleolar organizers are summarized in Fig. 2.

Differences in breakage between the different cell types are immediately apparent. But as radiation breakage has been shown to be at random^{13,14} and proportional to chromosome-length¹, breakage frequencies must be corrected to allow valid comparisons between different cell types to be made. Statistical tests can then be applied after making allowances for changes in total chromosome-length per cell resulting from the deficiencies and duplications induced by maleic hydrazide. The frequencies shown in Fig. 2 have been corrected in relation to the normal chromosome complement in this way.

Breakage in cells with 3, 4 and 5 nucleolar organizers is significantly lower than in cells with two

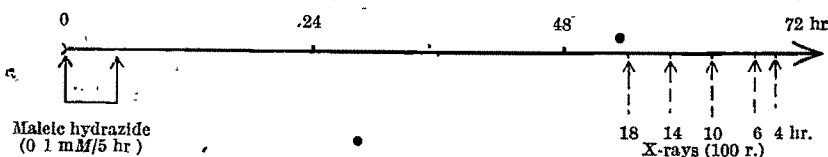


Fig. 1. Scale showing times at which roots were irradiated in relation to their earlier treatment with maleic hydrazide

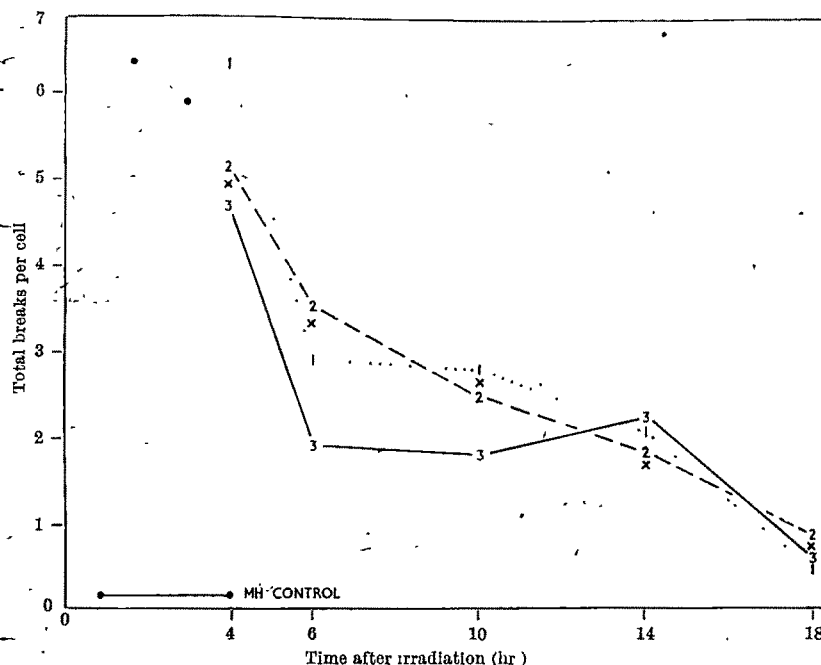


Fig. 2. Graph showing breakage frequencies in various cell classes at different times after 100 r. 1, cells with one nucleolar organizer; 2, with two organizers; 3, with three, four and five organizers (values lumped as they show no significant differences); 4, X-ray control. Cells without nucleolar organizers do not undergo mitosis. There is a low frequency of chemical breakage due to the maleic hydrazide treatment

organizers both at 10 hr. (7 d.f., $p < 0.05$) and at 6 hr. (10 d.f., $p < 0.001$). None of the other differences is significant. Apart from a possible exception at 4 hr., cells with one nucleolar organizer are less sensitive than might have been expected. This may be due to the proximity of cells with extra organizers, all having been derived from the same original cell.

What causes this decreased sensitivity in cells with extra nucleolar organizers at these particular times?

It is unlikely to be due to differences in mitotic rates for the following reason. Cells show differences in the incidence of B' and B'' according to the time of irradiation in relation to the time of split. Thus the ratio B'/B'' for each cell class gives an indication of its relative speed of development and shows in these experiments that there are no significant differences between cells with different chromosome complements. However, there is a slight indication that cells with one nucleolar organizer have a longer mitotic cycle; but more data are required to settle this point.

It seems more likely that the sensitivity differences are related to synthesis periods in interphase.

Howard and Pelc¹² have estimated that in root meristem cells of *Vicia faba*, DNA synthesis occupies 6 hr. and ends 8 hr. before the beginning of visible prophase; and in cells subjected to X-rays at specific times (which are spanned by my own fixations)

mitosis is delayed by 4 hr. In the present experiments, using the timing of Howard and Pelc, DNA synthesis probably ends about 14 hr. before metaphase. If so, cells with extra nucleolar organizers show their difference in sensitivity shortly after synthesis is completed. Here it is interesting to note that Thoday¹⁵ has related important changes in the types of breakage and reunion in *Vicia* to the timing of DNA synthesis by Howard and Pelc.

In my experiments, the differences in sensitivity last less than 10 hr. Possibly this covers a second and later synthesis period, in which the nucleolus plays an important part, between the end of DNA synthesis and the beginning of prophase. The occurrence of such an additional period has already been inferred¹².

It is difficult to imagine how the presence of extra nucleolar organizers could reduce initial breakage. It seems more likely that they favour a higher frequency of restitution. Unfortunately, the types of reunion seen at metaphase are of little use in solving this problem.

Similar results have been obtained by La Cour⁸ in *Hyacinthus*, where breakage is lowered in a trisomic

variety having an extra nucleolar chromosome. In *Vicia* the fact that a high proportion of the extra nucleolar organizers are present in active micronuclei shows that they act through the cytoplasm.

At present there is no evidence that other chromosome elements can affect sensitivity. Although the nucleolar organizers are essential in this system, the acentrics which carry them also carry small but varying amounts of heterochromatin; the relative importance of this heterochromatin is therefore still uncertain. However, a more detailed study of the frequency with which these acentrics form viable micronuclei should throw more light on this problem.

¹ Bishop, C. J., *Canad. J. Bot.*, **30**, 139 (1953).

² Darlington, C. D., and La Cour, L. F., *J. Genet.*, **46**, 180 (1945).

³ Conger, A., *Amer. J. Bot.*, **34**, 582 (1947).

⁴ Sparrow, A. H., *Ann. N.Y. Acad. Sci.*, **51**, 1508 (1951).

⁵ Swanson, C. P., *Genetics*, **29**, 61 (1944).

⁶ Thoday, J. M., and Read, J., *Nature*, **180**, 608 (1947).

⁷ Smith, L., *Amer. J. Bot.*, **29**, 189 (1942).

⁸ La Cour, L. F., *Heredity*, **6** (suppl.), 188 (1952).

⁹ McLeish, J., *Heredity*, **6** (suppl.), 125 (1952).

¹⁰ McLeish, J., *Heredity*, **8**, 385 (1954).

¹¹ Gray, L. H., and Scholes, M. E., *Brit. J. Radiol.*, **24** (1951).

¹² Howard, A., and Pelc, R., *Heredity*, **6** (suppl.), 281 (1952).

¹³ Ford, C. E., *Proc. Int. Genet. Congr.*, Stockholm, p. 570 (1948).

¹⁴ Revell, S. H., *Heredity*, **6** (suppl.), 107 (1952).

¹⁵ Thoday, J. M., *New Phytol.*, **53**, 611 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Rock Magnetism in Iceland

RECENT studies by J. Hospers¹ have revealed that Icelandic basalts fall into two groups with respect to their remanent magnetization. In one group the direction of magnetization is close to the present direction of the geomagnetic field. In the other group the magnetization has the opposite direction. Intermediate directions are rarely found. Studies made by A. Roche² have revealed the same fact for French basalts of Quaternary and Tertiary age. These findings have been interpreted in terms of repeated reversals of the geomagnetic field.

For an extensive survey of the two magnetic groups it is necessary to use a quicker and more convenient method than that of conventional magnetometer measurements in order to distinguish one group from the other. It is of primary importance to be able to tell in the field to which group a certain rock formation belongs.

For this purpose we have used an ordinary field compass. A specimen of convenient size is removed from the rock, and its magnetic polarity tested by moving it close to the compass. In most cases the permanent magnetization of basalt is strong enough to give an easily detected deflexion of the magnetic needle. If the north magnetic pole of the specimen points downwards when this is placed in the original position, the specimen is normally magnetized; if it points upwards it is inversely magnetized.

During the year 1954 we examined several thousand specimens distributed over all parts of Iceland. This study has revealed close correspondence of the magnetization with distinct formations. As a rule, specimens taken from the same volcanic formation all have the same polarity.

Exceptions are found in old basalts where a weak and irregular magnetization sometimes prevents the determination of the polarity of the rock formation as a whole. In conglomerates the rounded pebbles usually show a random distribution of polarization; but occasionally conglomerates with uniform polarization have been found in the older rocks. In recent conglomerates which have been under the influence of hot-spring water normal polarization has been found prevailing in basalt pebbles taken at the surface, although the underlying basaltic layers which have been exposed to the same temperature (c. 100° C.) retain the original inverse magnetization as revealed by cores from bore-holes. It therefore seems likely that the change in magnetization of the pebbles is due to chemical alteration promoted by presence of the oxygen of the air. Irregular magnetization in old basalts may have a similar explanation.

On level ground it is customary to find a uniform magnetization extending over an area of some tens or hundreds of square kilometres.

In basaltic mountains built up of nearly horizontal lava-flows, of 5-10 m. thickness each, we find layers of normal and inverse magnetic polarization respectively one on top of the other. Each of these magnetic ensembles contains from several to more than one hundred lava-flows. The boundaries between the magnetic ensembles are distinct and

usually follow a layer of sediments separating the basaltic flows.

The total thickness of sections we have tested in different parts of Iceland is 21,000 m. 10,000 m. have been found normally magnetized, 9,000 m. inversely magnetized and 2,000 m. irregularly magnetized.

From this we conclude that the amount of inversely magnetized basalt in Iceland is of similar magnitude to that of the normally magnetized.

As to area, we find a greater extension of normal than of inverse polarization; but this is only due to the fact that a large part of the country is covered by tuffs and lavas younger than Lower Quaternary and all these young rocks are found normally magnetized.

Between the basaltic lava-flows there are frequently thin layers of red baked clay which is just as strongly magnetized as the basalt itself. This clay always shows the same polarization as the basalt on top of it.

Basaltic dykes usually show a regular polarization. The same polarization is always found in the country rock close to the dyke regardless of whether it cuts through basalt or clay.

This has been tested for all combinations of dyke and country rock magnetization.

To explain the fact that widely different materials which were erupted or heated during certain periods of time all acquire an inverse magnetization, we see no other possibility than to assume that the magnetic field of the earth had the opposite direction of what it has to-day. Our observations indicate that there are found in the Icelandic basalts at least three periods, during which there was reversion of the magnetic field. The last period of reversion seems to cover the Pliocene-Pleistocene boundary and may thus be compared with the last period of inverse magnetization in France, as found by Roche. If parallelism with Roche's findings is assumed for the older units, the Icelandic rocks tested by us reach back to the Oligocene.

This field work will be further extended in order to map the distribution of the various magnetic ensembles. In continuation of the field survey exact laboratory measurements of rock magnetism with an accurate magnetometer are now in progress.

TRAUSTI EINARSSON

University of Iceland,
Reykjavik.

THORBJÖRN SIGURGEIRSSON
National Research Council,
Reykjavik.

¹ Hospers, J., *Nature*, 188, 1111 (1951); *Proc. K. Ned. Akad. Wet.*, B, 56, 497 (1953); B, 57, 112 (1954).

² Roche, A., *C.R. Acad. Sci., Paris*, 238, 107 (1953).

Geophysical Work in North Greenland

THE purpose of this communication is to record briefly those results of the geophysical work of the British North Greenland Expedition which would be of interest to others visiting this area.

One of the aims of the work was to measure thicknesses of ice by seismic reflexion methods at points along the traverses indicated on the map, Fig. 1. In the first year of the Expedition (1953) a 6-channel reflexion unit was used, in the second a 12-channel unit.

Except near the extreme eastern edge of the ice-sheet, no definite reflexions from an ice-bedrock interface were detected east of a line running approx-

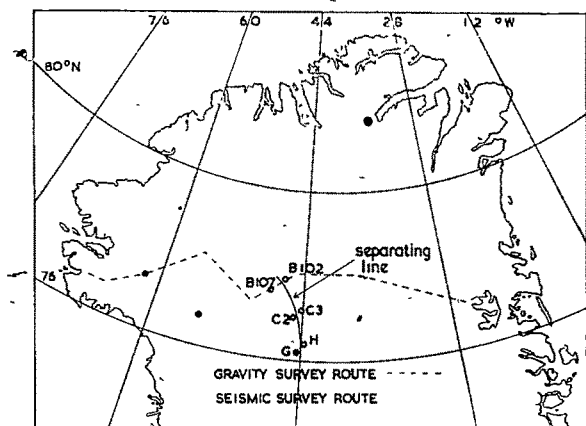


Fig. 1. Map of North Greenland showing position of line separating reflecting and non-reflecting seismic areas

imately 330° , the position of which is shown on the map. Definite reflexions were obtained west of the line, the three stations closest to it and at which reflexions were detected being: B 107 ($77^\circ 40' \text{ N.}$, $47^\circ 58' \text{ W.}$), C 2 ($77^\circ 02' \text{ N.}$, $45^\circ 08' \text{ W.}$) and G ($76^\circ 13' \text{ N.}$, $44^\circ 22' \text{ W.}$). East of the line, no reflexions were detected at B 102 ($77^\circ 56' \text{ N.}$, $46^\circ 27' \text{ W.}$), at C 3 ($77^\circ 12' \text{ N.}$, $44^\circ 02' \text{ W.}$) or at H ($76^\circ 26' \text{ N.}$, $43^\circ 36' \text{ W.}$). The distances between the pairs of stations B 107 and B 102, C 2 and C 3, G and H are all approximately 35 km.

Various field techniques were employed at each station. At those west of the line the best reflexions were obtained with Poulter air-pattern shooting, although reflexions were obtained with single air shots. Using identical shooting and geophone patterns at stations east of the line, no reflexions were obtained.

The altitudes of these six stations are between 2,516 metres (station B 102) and 2,780 metres (station G). The ice thicknesses at B 107, C 2 and G are approximately 2,700, 2,650 and 2,950 metres, respectively. West of the line, the bedrock surface rises to the west, the average slope being about 10 m. per km.

Values of gravity were determined along a traverse passing through stations B 102 and B 107. A plot of the values of the free-air anomalies shows a discontinuity between the station at $77^\circ 54' \text{ N.}$, $46^\circ 37' \text{ W.}$ and that at $77^\circ 53' \text{ N.}$, $46^\circ 46' \text{ W.}$, superimposed on the regional trend of the anomalies. The magnitude of the jump is approximately 4 mgal., the anomaly being algebraically greater to the west. Between these two stations the mean horizontal gradient of the free-air anomaly is thus 0.8 mgal. per km., compared with a gradient for the regional trend of about 0.15 mgal. per km. However, larger gradients of the free-air anomaly are found in other parts of the ice-sheet, both east and west of the line separating the areas where seismic reflexions are and are not obtained.

A full discussion of these results will be given elsewhere.

R. J. M. BRUCE

N.V. De Bataafsche Petroleum Maatschappij.

C. BOM

Department of Geodesy and Geophysics,

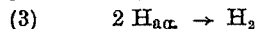
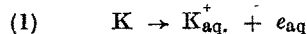
Downing Place, Cambridge.

March 22.

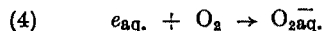
Electrons in Solutions

THE possibility of a stable bound state of the electron in water and in similar media is of importance in many fields of chemistry in which electron-transfer phenomena play a part. In photochemistry and in radiation chemistry particularly, there have been recently several discussions of this problem¹. Since no definite conclusions have been reached, we have recently reconsidered the problem (Barelli, K., and Stein, G., unpublished work). Several independent methods used by us point to the same conclusion, namely, that the aqueous medium does possess an electron affinity. Regarding the quantitative value of the energy of binding, two hypothetical bound states of the electron in water were indicated. Some of the methods used by us indicated that in the first of these, which may be denoted by $e_{aq.}$, the electron is bound with an energy of approximately 25 kcal./mole. In the other hypothetical state, which was obtained by the use of a different approach and which may be denoted by $H_2O_{aq.}$, the electron would be bound with an energy of the order of 70 kcal./mole.

Each of the methods used was sufficiently uncertain to make further experimental support very desirable. In 1934 Fernelius recorded an observation² which hinted at the possibility of obtaining such experimental evidence. In an attempt to obtain the most favourable experimental conditions, we have now distilled metallic potassium *in vacuo* and studied the reaction of the freshly distilled potassium in the same vessel cooled to -10°C. in the total absence of oxygen with water at 0°C. During the reaction the temperature did not rise above -5°C. A solution results, the spectrum of which is shown in Fig. 1. The colour decays by two processes: (a) thermally, with the evolution of hydrogen, presumably according to the stages:



(b) on the admission of oxygen, according to



with the spectrum changing accordingly.

Using metallic sodium under similar conditions, less-pronounced though similar phenomena occur.

When the freshly distilled metals reacted with cooled absolute methanol or ethanol at -40°C. in the total absence of oxygen, bluish-coloured solutions were obtained. The colour decayed by the two processes described above and also by a third

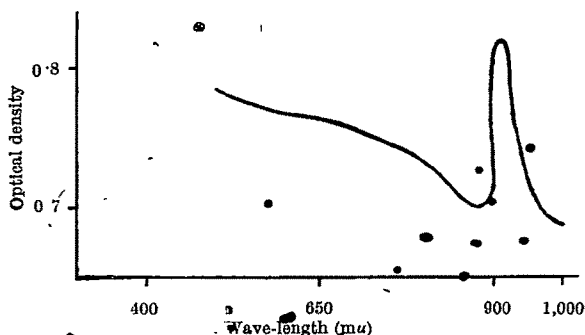


Fig. 1. Absorption spectrum of potassium in water at -3°C. in the absence of oxygen

process, accompanied by a rapid evolution of hydrogen, when water was added to the coloured absolute alcoholic solutions.

The properties of these systems are being investigated and we hope to publish full details in the future.

JOSHUA JORTNER
GABRIEL STEIN

Department of Physical Chemistry,
Hebrew University,
Jerusalem.
March 3.

- ¹ Platzman, R. L., and Franck, J., "Farkas Memorial Volume", 21 (1952). Platzman, R. L., "Basic Mechanisms in Radiobiology" (Nat. Acad. Sci. Pub. 305, 1, and discussion, 1953). Magee, J. L. *ibid.*, 51. Dewhurst, H. A., Samuel, A. H., and Magee, J. L., *Radiation Res.*, 1, 62 (1954). Stein, G., *Farad. Soc. Discuss.*, 12, 227, 289 (1952). Magee, J. L., *ibid.*, 288.
- ² Wolthorn, H. J., and Fernelius, W. C., *J. Amer. Chem. Soc.*, 56, 1551 (1934).

The Hydrogen Atoms in Alpha-Resorcinol

As the first example of the location of hydrogen atoms in aromatic molecules by single-crystal neutron diffraction methods, we have studied α -resorcinol, $C_6H_4(OH)_2$. This substance was examined with X-rays in 1936 by Robertson¹, who located the carbon and oxygen atoms in the structure, concluding that there were O—H—O bonds of lengths 2.66 and 2.75 Å. which formed infinite helices throughout the crystal.

Our preliminary Fourier projection of the neutron scattering density on the (001) plane is given in Fig. 1, which shows a resorcinol molecule, inclined at 61° to the plane of the projection, together with the hydroxyl groups of neighbouring molecules. All the hydrogen atoms, which have a negative scattering amplitude for neutrons, are clearly defined. Those which are attached to the benzene ring have a C—H distance of approximately 1.1 Å. The hydrogen bonds which link the molecule to its neighbours are non-symmetrical, with the proton about 1 Å. away from the nearer oxygen atom.

We are at present refining the structure by difference syntheses in order to determine these bond-lengths accurately, and full details of this work will be published in due course.

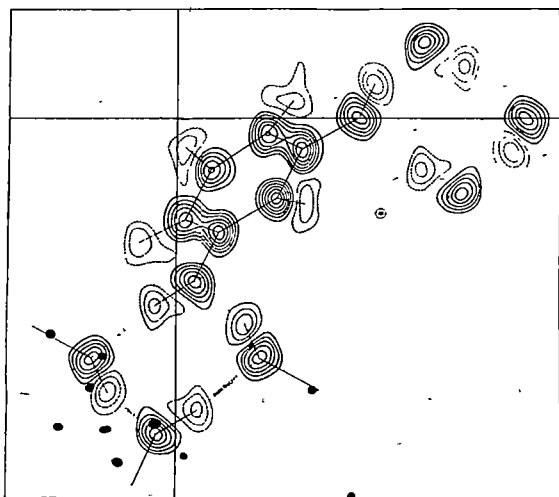


Fig. 1. A projection on the (001) plane of the neutron scattering density for α -resorcinol. The full lines are positive contours (carbon, oxygen); the dotted lines are negative contours (hydrogen).

We acknowledge the assistance of Mr. S. A. Wilson, who grew our single crystals of resorcinol.

G. E. BACON
N. A. CURRY

Atomic Energy Research Establishment,
Harwell, Didcot, Berks.
March 7.

¹ Robertson, J. M., *Proc. Roy. Soc., A*, 157, 79 (1936).

Detection of Free Radicals in Polyacrylonitrile by Paramagnetic Resonance

EVIDENCE has been presented¹ that, during the polymerization of vinyl monomers under conditions such that precipitation of the polymer occurs, the propagating free radicals become occluded by the polymer with a resulting decrease in their accessibility for reaction. The effective rate-coefficients for the free radical reactions, particularly that of chain termination, are thus reduced, giving rise to the characteristic kinetic features observed in heterogeneous vinyl polymerizations. In the case of acrylonitrile, extreme degrees of occlusion may be reached, leading to the presence in the polymer of trapped radicals for which the propagation and termination coefficients are practically zero. The concentration of these radicals has been estimated by reaction with $\alpha\alpha$ -diphenyl β -picryl hydrazyl². We now wish to report the detection and estimation of trapped radicals by observation of the paramagnetic resonance absorption spectrum of the polymer. This method has already been employed to detect radicals in activated carbon and other carbonaceous solids^{3,4}, and also in gel systems prepared from cross-linked vinyl polymers⁵.

Acrylonitrile was polymerized photochemically in a tube of $\frac{1}{4}$ in. diameter with di-*tert*-butyl peroxide (10 per cent v/v) as catalyst. The rate was 7×10^{-5} mol.lit.⁻¹sec.⁻¹. After 20 per cent conversion the unchanged monomer and catalyst were distilled off in vacuum and the tube sealed. The paramagnetic resonance absorption spectrum of the polymer was observed at room temperature at a wave-length of 3 cm., and also at 90° K. and 20° K. at 1.25 cm. The tube containing the polymer was first inserted into an H_{012} 3 cm. wave-length rectangular resonant cavity, when an absorption line with a width of about 20 gauss and a spectroscopic splitting factor of 2.00 ± 0.01 was observed, using a normal crystal-video system of detection. Comparison of the integrated intensity of the signal with that obtained from low-temperature carbon samples calibrated directly against diphenyl picryl hydrazyl⁴ indicated that the concentration of unpaired electrons present in the polyacrylonitrile was about 10^{17} per ml. (based on the initial monomer volume). The concentration of free radicals determined by the chemical method using diphenyl picryl hydrazyl may be seen from a short extrapolation of the line in Fig. 3 of ref. 2 to be approximately 8×10^{-5} mol.lit.⁻¹ or 5×10^{16} radicals per ml. The agreement between the two completely independent methods of radical counting is highly satisfactory. Even under the favourable conditions used in these experiments, only about 1–2 per cent of the total number of radicals generated become trapped: hence it is clear that no kinetic treatment of the polymerization which embodies termination predominantly by radical occlusion is valid.

The effect of admitting air to the polyacrylonitrile sample was also studied by breaking off the tip of

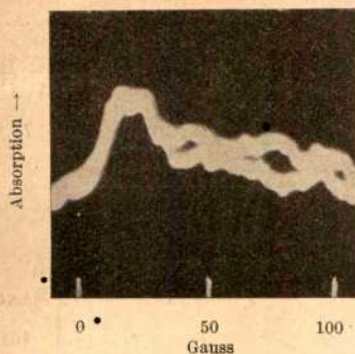


Fig. 1

the tube while observing the signal. No immediate change was noticed; but the intensity was found to fall gradually, until after half an hour the signal was lost in the noise. This rather slow reduction of signal strength on admission of air was confirmed in the low-temperature experiments. In these, some of the material was packed into a small 'Distrene' cup immediately after contact with air, and then studied at liquid-oxygen and -hydrogen temperatures. A standard type of low-temperature H_{111} cylindrical cavity was used. The signal obtained at 20° K. from such a sample is illustrated in Fig. 1; at this temperature no noticeable change in intensity with time was observed. Material from the same sample was again studied a few hours after the initial contact with the atmosphere, after standing at room temperature, when no trace of the absorption line could be found. The destruction of the trapped radicals following contact with air has previously been deduced from studies of the fast reaction¹. It may result from reaction with oxygen to form

$\text{—C—OO}\cdot$ radicals, and subsequent splitting off of $\text{HO}_2\cdot$ radicals which are then free to interact to form non-radical products. The formation of $\text{HO}_2\cdot$ may be a comparatively slow process requiring appreciable activation energy.

One other feature of interest is that the line-width appears to be greater at 20° K. than at 90° K. This may suggest a form of 'motional narrowing' interaction⁶ at the higher temperature.

These studies are being continued, and will be extended to include the polymerization of other monomers.

C. H. BAMFORD
A. D. JENKINS

Courtaulds, Ltd.,
Research Laboratory,
Maidenhead, Berks.

D. J. E. INGRAM
M. C. R. SYMONS

Department of Electronics,
Department of Chemistry,
University of Southampton.
March 17.

¹ Bamford, C. H., and Jenkins, A. D., *Proc. Roy. Soc., A*, **216**, 515 (1953).

² Bamford, C. H., and Jenkins, A. D., *Proc. Roy. Soc., A*, **228**, 220 (1955).

³ Ingram, D. J. E., and Bennett, J. E., *Phil. Mag.*, **45**, 545 (1954).

⁴ Ingram, D. J. E., Tapley, J. G., Jackson, R., Bond, R. L., and Murnaghan, A. R., *Nature*, **174**, 797 (1954).

⁵ Fraenkel, G. K., Hirshon, J. M., and Walling, C. J., *Amer. Chem. Soc.*, **76**, 3806 (1954).

⁶ Singer, L. S., and Spencer, E. G., *J. Chem. Phys.*, **21**, 939 (1953).

• Melting Behaviour of Crystalline Polymer Fibres

In a recent study of the specific heats of 6·6 and 6·10 nylons, Wilhoit and Dole¹ obtained melting curves in which the peak for drawn filaments occurred at a lower temperature than for the corresponding undrawn filaments. They considered that the forms of these curves suggested that in 6·6 nylon drawn yarn, part of, if not all, the nylon melts and then perhaps recrystallizes and melts again. Alternatively, it was suggested that a considerable fraction melts at one temperature and a significant fraction at a higher temperature.

Using differential thermal analysis, we have now shown that, in the melting of drawn yarns of certain crystalline polymers, two distinct heat absorptions occur in separate temperature regions. These two heat changes appear to accompany respectively the disorientation of crystalline regions and then actual fusion of the crystallites, rather than the transformation or melting of polymorphs. The melting curves for the polymer in bulk and for the undrawn filaments indicate a single broad range of heat absorption.

Typical forms of differential heating curves obtained during the melting of 6·6 nylon filaments, using heating-rates of 0·5–1·5 deg. C./min., are shown in Fig. 1.

The development of the broad heat absorption peak 240–265° C. for undrawn 6·6 nylon yarn into two distinct peaks 240–257° C. and 259–265° C. on drawing has been followed, using a series of melt-spun yarns cold-drawn up to extensions of about 400 per cent; ΔH (240–265° C.) values depend upon the degree of drawing and are, in general, greater for the drawn yarns.

On slowly heating drawn 6·6 nylon yarn to 258° C. and cooling it slowly to room temperature, the yarn retains its physical form and shows no sign of fusion. However, the X-ray diffraction pattern, the optical

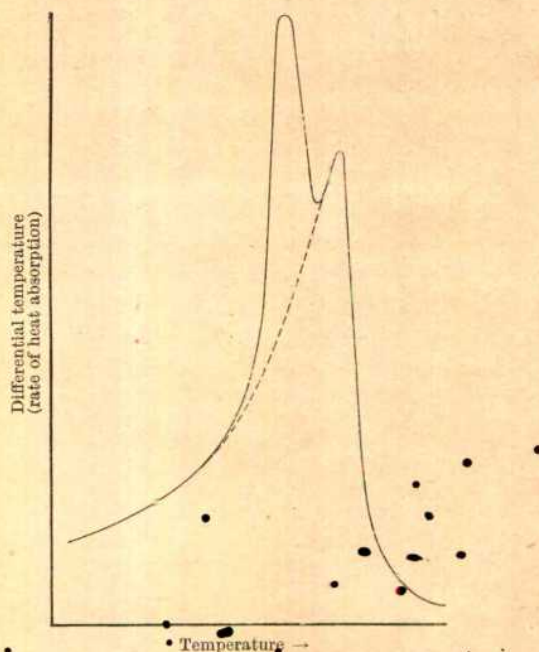


Fig. 1. Differential heating curves for melting 6·6 nylon fibres; — — —, undrawn yarn; —, drawn yarn

birefringence and the melting curve all revert to those characteristic of undrawn yarn, with random orientation of crystalline regions. We consider, therefore, that the heat absorption shown by drawn 6.6 nylon yarn in the range 240–257° C. is associated with disorientation of the crystalline regions and that, because of the strong interchain forces existing in the 6.6 nylon crystal structure, actual fusion of the crystallites does not occur until slightly higher temperatures are attained.

The occurrence of two heat changes in separate temperature ranges has also been noted by us on melting drawn fibres of polyethylene terephthalate, 6 and 6.10 nylons, certain co-polyamides and, to some extent, the polyurethane, 'Perlon U'. Drawn fibres of polyethylene and 11 nylon show only a single broad heat absorption-range in which disorientation and melting occur simultaneously.

The actual shape of the melting curve, at fixed heating-rates, of drawn yarns showing the two heat changes in the melting range depends on the crystallinity and the degree of orientation of the crystallites. Although structural changes occur in the yarns during the course of heating up to the melting temperatures, the melting curves are a valuable method for characterization. Small differences in the degree of orientation of highly oriented yarns such as polyamide or polyester tyre-cords are detected more readily than is possible by X-ray methods. Furthermore, the method is sometimes applicable when the yarn is in a form which precludes X-ray or optical methods, for example, when highly twisted or woven. A disadvantage is that the sample is necessarily destroyed. The method has been applied to problems which require a study of changes in fine structure of nylon yarns.

Fuller details of this work will be published elsewhere. I wish to thank British Nylon Spinners, Ltd., for permission to publish this communication.

T. R. WHITE

Research Department,
British Nylon Spinners, Ltd.,
Pontypool, Mon.
Jan. 20.

¹ Wilhoit, R. C., and Dole, M., *J. Phys. Chem.*, **57**, 14 (1953).

An Easily Assembled Continuous Electrophoresis Apparatus

DESIGNS for apparatus for continuous electrophoresis employing an electrical field perpendicular to gravity flow have included anticonvective media supported between plates¹, and filter paper as an anticonvective medium supported between plates² and hung like a curtain³. Construction of such equipment has tended to discourage the use of this method of isolation, particularly when exploratory experiments are necessary to assay the applicability of continuous electrophoresis to a particular problem.

The design described in this communication requires little special equipment and may be assembled from glassware usually found in the laboratory. A standard 'Pyrex' cylindrical jar (6 in. × 8½ in.) is used for supporting a sheet of filter paper, the sample container, the buffer solution, and the buffer flow system (Fig. 1). The sheet of filter paper serrated at the lower edge is wet and wrapped around the cylinder in a manner to exclude bubbles between the cylinder and filter

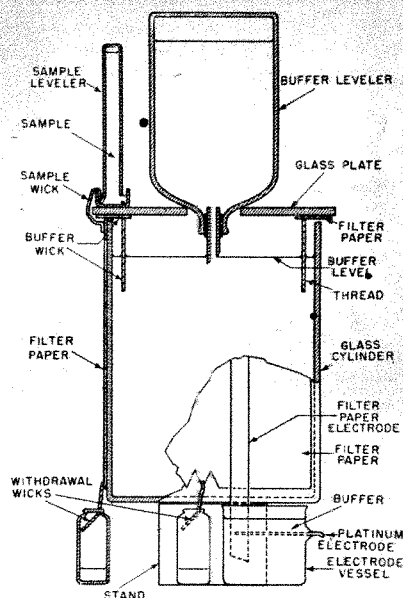


Fig. 1. Drawing of continuous electrophoresis apparatus

paper. For a single sample, a filter paper sheet with a length (when wet) of $\frac{1}{4}$ to $\frac{1}{2}$ in. less than that of the outer circumference of the cylinder is used. The paper sheet is allowed to project about $\frac{1}{8}$ in. above the edge of the cylinder and is folded over to make contact with the buffer wick. The buffer wick is the type designed by Irreverre and Martin⁴ for use in descending chromatography. A glass plate $\frac{1}{4}$ in. thick is placed on top of the buffer wick. This plate with a $1\frac{1}{2}$ -in. diameter hole drilled in its centre acts both as a press to keep the bent edge of the filter paper sheet and the buffer wick in good contact and also as a support for the inverted bottle containing the buffer solution. The inverted bottle of buffer, when equipped with a tube of the correct internal diameter (approximately 11 mm.), serves to keep constant the level of the buffer inside the cylinder. The solution of sample with its own levelling system is also supported on the glass plate. The usual wick carries the sample solution to the filter paper. Surface tension is sufficient to hold the sample wick in contact with the paper. The two electrode wicks, each consisting of a stack of three strips of filter paper $\frac{1}{2}$ in. × 1 ft., are wet and placed in contact with the wet filter paper with the freely hanging ends of the electrode wicks dipping into the electrode vessels. Samples are withdrawn from the serrations cut in the filter paper with wicks of wet cotton thread approximately 1 mm. in diameter held in place by surface tension. The whole apparatus is covered with a plastic bell cover made from a sheet of 'Lucite', 24 in. × 46 in. × $\frac{1}{8}$ in.

Our original interest in the use of this method was in separating amino-acids. An example of one experiment is illustrated in Fig. 2, where a mixture of 0.02 M of each of the amino-acids, alanine, arginine, glutamic acid, glycine and valine, were separated at pH 5.2 into the acid, basic and neutral species. The buffer was ammonium acetate, ionic strength 0.01; the current was 8 m.amp.; the solvent flow was 10 ml. per hr. through a total of twenty-five serrations spaced $\frac{1}{2}$ in. apart; and the sample flow was 0.2 ml. per hr.

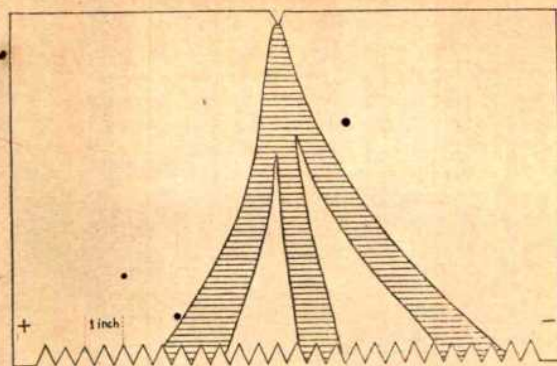


Fig. 2. Illustrative experiment on acid, basic and neutral amino-acid mixture

Apart from the ease of assembly and low cost, the apparatus has the following advantages: (1) buffer flow may be controlled by varying the number of threads in the buffer wick and by changing the buffer level; (2) the cylinder of buffer lowers the steady-state temperature; for example, with a current of 15 m.amp. and a room temperature of 28° C., the steady-state temperature was 32° C.; and (3) two samples may be run simultaneously by wrapping the sheet of filter paper completely around the cylinder. One electrode wick is placed over the joined edges of the filter paper, while the other electrode wick is placed on the opposite side of the cylinder. The result is a symmetrical arrangement allowing the use of two different samples.

H. A. SAROFF

National Institute of Arthritis
and Metabolic Diseases,
National Institutes of Health,
Public Health Service,
U.S. Department of Health,
Education and Welfare,
Bethesda, Maryland.
Dec. 21.

- ¹ Svensson, H., and Brattsten, L., *Arkiv Kemi*, 1, 401 (1949).
² Strain, H. H., and Sullivan, J. C., *Anal. Chem.*, 23, 816 (1951).
Brattsten, L., and Nilsson, A., *Arkiv Kemi*, 3, 337 (1951).
³ Durrum, E. H., *J. Amer. Chem. Soc.*, 73, 4875 (1951).
⁴ Irreverre, F., and Martin, W., *Anal. Chem.*, 26, 257 (1954).

A Simple Paper Chromatographic Technique for the Study of Free Metabolites of Tissues and Body Fluids

Buzzati-Traverso and Rechnitzer proposed a simple chromatographic technique for taxonomic studies on fishes¹; Buzzati-Traverso applied it also to genetic studies on *Drosophila*². In the original technique, the tissues were simply squeezed on filter paper, dried and chromatographed. The method was used almost as such by some authors for taxonomic studies on land snails³, mosquitoes⁴, and for investigating several mouse and tumour tissues⁵. The present method, although starting from the same principle, was developed in a rather different manner. It does not utilize fresh tissues, but tissues which have been dried and powdered. By this means it is possible to use an accurately known amount of tissue, independently of its water content, and to extract completely the free metabolites from the broken cells; furthermore, the samples used may be larger,

thus allowing the detection of metabolites which may be present in amounts too small to be detected by the use of small pieces of tissue.

This procedure was made possible by employing a modified paper-disk chromatographic technique. A sheet of Schleicher and Schull 2043 B filter paper is sandwiched between two glass plates 25 cm. × 25 cm. One of these plates has a central hole 6 mm. in diameter. The tissue sample, taken from exsanguinated animals, is dried at 100° C. This temperature of desiccation has been found to give the best results, and seems not to alter most of the free metabolites studied. For serum, half a millilitre is dried in the same manner. For metabolites unstable to heat the tissue may be lyophilized. The dry tissue or serum is then reduced to a fine powder by grinding it in a mortar; 5–10 mgm. is weighed (for serum 15–20 mgm.) and evenly distributed in the hole of the glass plate. A small filter-paper disk, 6 mm. in diameter, is gently pressed on the powder to keep it in place, and is lightly wetted with the solvent. The plate is then inverted over a small dish containing the wick, the base of which is immersed in 10 ml. of the solvent. The wick consists of a cone of filter paper the base of which has the same diameter as the internal diameter of the dish and the height of which is about 2 mm. greater than the dish itself.

When inverting the plate over the dish, care must be taken that the tip of the wick adheres exactly to the centre of the disk supporting the material. The small, closed chamber formed by the dish and the plate soon becomes saturated with the solvent vapour, and the solvent flows regularly through the material under study, extracting its free components and chromatographing them.

The solvent is allowed to flow 10 cm. from the centre. It takes about seven hours to reach this distance when the mixture *n*-butanol/water/acetic acid (100:100:24) is used, and about twelve hours for the mixture tertiary-butanol/formic acid/water (70:15:15). This distance must be carefully controlled, in order to be able to compare directly the different chromatograms. After drying, the chromatograms are observed under Wood's light to detect their fluorescence patterns; then they may be cut in sectors and on each sector a different reaction may be performed.

The relative position of the different bands in the ultra-violet, the ninhydrin reaction and other reactions, may be, in this manner, established by direct comparison.

The method allows very good separations, perhaps because the solvent flows straight through the substance to be chromatographed (Fig. 1), and it seems

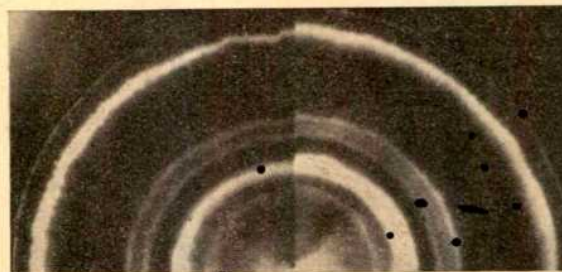


Fig. 1. Autoradiograph of chromatograms of rat thyroid 16 hr. after intraperitoneal injection of 300 µc. of iodine-131. Each half of the figure represents the thyroid of a single animal. Solvent: normal butanol/water/acetic acid (100:100:24)

to be susceptible of the widest application both for natural and unnatural metabolites.

Several problems are now under investigation in our laboratory by its use; for example, the amino-acid composition of different normal organs, comparison between normal and tumour tissues and sera and the distribution of labelled amino-acids. We are also elaborating a method for a quantitative estimation of the free amino-acids separated by circular paper chromatography.

GIOVANNI CERIOTTI

Centro Tumori, Busto Arsizio,
Varese, Italy. Jan. 17.

¹ Buzzati-Traverso, A. A., and Rechnitzer, A. B., *Science*, **117**, 58 (1953).

² Buzzati-Traverso, A. A., *Nature*, **171**, 575 (1953).

³ Kirk, R. L., Main, A. R., and Beyer, F. G., *Biochem. J.*, **57**, 440 (1954).

⁴ Micks, D. W., *Nature*, **174**, 217 (1954).

⁵ Rogers, S., and Berton, W. M., *Amer. J. Path.*, **30**, 622 (1954).

Chromatography of Serum and some other Proteins on an Anion-exchange Resin

CATION-EXCHANGE resins have proved suitable as adsorbents for chromatographing a number of proteins (see a review by Zittle¹). Last year, however, Sober and Peterson² reported the use of an anion-exchanger as an adsorbent in protein chromatography. These authors used 'DEAE-Polycel' (prepared from cellulose) for the chromatographic purification of kidney amidase and some other enzymes. The purpose of the present communication is to describe another system for anion-exchange chromatography of proteins which appears to be useful for a number of rather different proteins.

The resin used was Dowex 2, 200-400 mesh, brought to the chloride form by washing with 1 N sodium chloride. After an experiment, the column is regenerated with 1 N hydrochloric acid and then washed with starting buffer solution until the pH is unchanged after passing through the resin. Tris (hydroxymethyl) aminomethane hydrochloride (Sigma Chemical Co. Tech. Bull. 106) has been used as the buffer system. Since pH control is particularly important in protein chromatography, it is an advantage to have a cation with buffer capacity when working with an anion-exchange resin.

As in the studies of Tiselius³ with calcium phosphate columns, elution of different proteins takes place in narrow intervals, so that a comparatively small increase in buffer concentration brings the R_F from about zero to about 1.0. The experiments recorded here were performed in such a way that the proteins were adsorbed at low ionic strength and eluted by a stepwise increase in the buffer concentration, keeping the buffer pH constant at 7.2. The dimensions of the column were 18 cm. $\times$ 1.5 cm. Fractions were shifted every 30 min., which gave fraction volumes of about 3.3 ml. All experiments have been run in a cold room at 4°.

Fig. 1 shows results of an experiment with serum from a patient with prostatic cancer. The serum had been stored for two weeks in the frozen state. The amount applied was 0.5 ml. of serum dialysed against 0.02 M tris (hydroxymethyl) aminomethane buffer of pH 7.2. (During the dialysis some of the globulin material was precipitated and removed by centrifugation.) As can be seen from the figure, elution was first carried out with 0.02 M buffer and then with stepwise increases to molarities of 0.1, 0.2, 0.4 and 1.0 of buffer, keeping the pH constant at 7.2. The amount of protein in the different fractions was followed by the extinction at 280 m μ measured in a Beckman DU spectrophotometer using 1-cm. cells. It is well known from the work of Gutman and Gutman⁴ that prostatic cancer leads to highly increased values of the acid phosphatase activity in serum. For this reason, the different fractions from the experiment were tested also for acid phosphatase according to a modification of the method of Bessey *et al.*⁵. As seen in Fig. 1, most of the phosphatase activity (82 per cent of the activity applied) is found in the third zone. Attempts have been made to identify the different zones from the column by using paper electrophoresis. From these experiments it is clear that the second peak (tube 8 in Fig. 1) consists of almost pure albumin and the fourth peak (tube 21 in Fig. 1) of a well-defined γ -globulin fraction. The third peak is probably α_1 - and α_2 -globulin. The uncertainty here comes from the difficulty of concentrating the material without denaturation. However, zone electrophoresis experiments with a cellulose column, by the method of Flodin and Porath⁶, has shown that the phosphatase activity is not associated with the albumin or the γ -globulins; but due to the instability of the enzyme at alkaline pH, electrophoresis experiments failed to give further information. Fig. 1 also shows that the maximum amount of ultra-violet-absorbing material comes in tube 13, while the enzyme maximum is in tube 14. It is thus likely that other conditions can give a better resolu-

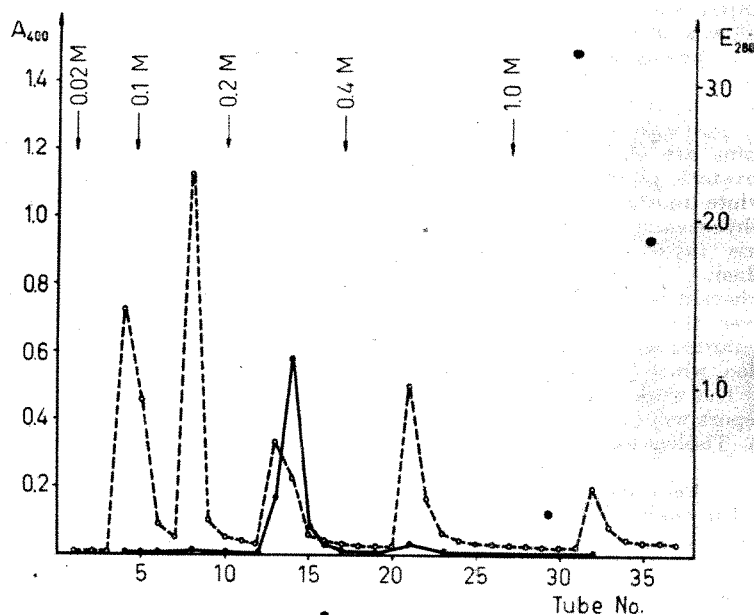


Fig. 1. Chromatography of serum from a patient with prostatic cancer. Open circles represent the extinction at 280 m μ and solid circles the acid phosphatase activity expressed in arbitrary units. The second peak consists of almost pure albumin and the fourth of a γ -globulin fraction.

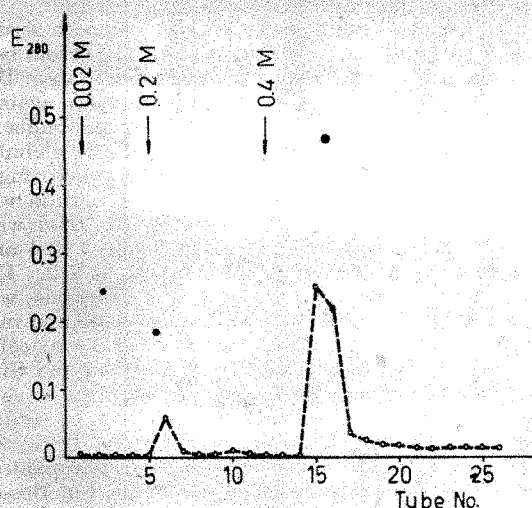


Fig. 2. Chromatographic experiment with a commercial sample of human serum albumin. The open circles represent extinction at 280 m μ . For further details, see text

tion of this zone. Finally, the first peak contains β -globulin and, in addition, at least some γ -globulin, which are not adsorbed under the conditions used here.

A commercial sample of human serum albumin has been studied on the same column as used in the serum experiment and under similar conditions. The result can be seen from Fig. 2. The main peak containing 52 per cent of the amount applied is not eluted until the buffer concentration is increased to 0.4 M. However, rechromatographing the albumin eluted at this buffer concentration only gave one narrow zone and a recovery of 87 per cent, calculated on the basis of the extinction at 280 m μ . These experiments make it probable that the commercial sample was no longer in the native state.

With the same chromatographic technique it has been possible to purify a vegetable acid phosphatase from a crude extract (Anagnostopoulos and Boman, unpublished work). This enzyme is not adsorbed on 'Dowex 50' and is thus chromatographically different from prostatic phosphatase⁷. Some purified proteins, prostatic phosphatase, haemoglobin, phycoerythrin and phycocyanin have also been studied and found to give narrow and well-defined zones. These proteins are eluted at the concentrations indicated: prostatic phosphatase 0.2 M, acid phosphatase from white mustard seeds 0.2 M, phycoerythrin 0.4 M, phycocyanin 0.4 M, all molarities with regard to tris (hydroxymethyl) aminomethane at pH 7.2. Haemoglobin is not adsorbed at this pH but at pH 8.3, where it is eluted at a buffer molarity of 0.1. However, these concentrations are not necessarily to be regarded as the minimum strengths required for elution, which have not yet been definitely determined.

The work is being continued, and a more detailed report will be published later. I wish to thank Prof. A. Tiselius for his interest in this work.

HANS G. BOMAN

Institute of Biochemistry,
University of Uppsala. March 14.

¹ Zittle, C. A., "Adv. in Enzym.", **14**, 319 (1953).

² Sober, H. A., and Peterson, E. A., *J. Amer. Chem. Soc.*, **76**, 1711 (1954).

³ Tiselius, A., *Ark. Kemi*, **7**, 443 (1954).

⁴ Gutman, A. B., and Gutman, E. B., *J. Clin. Invest.*, **17**, 473 (1938).

⁵ Bessey, O. A., Lowry, O. H., and Brock, M. J., *J. Biol. Chem.*, **164**, 321 (1946).

⁶ Flodin, P., and Porath, J., *Biochim. Biophys. Acta*, **19**, 175 (1954).

⁷ Boman, H. G., *Biochim. Biophys. Acta*, **10**, 245 (1955).

Inhibition of Induced Enzyme Formation by Purine Analogues

It has been shown that the enzyme β -galactosidase is inducible in *Staphylococcus aureus* if the organism is supplied with galactose and a mixture of amino-acids; enzyme formation in intact and disrupted cells is markedly stimulated by the presence of glucose and a mixture of purines and pyrimidines^{1,2}.

The purine analogues 8-azaguanine and 2:6-diaminopurine inhibit formation of the enzyme in intact cells by reducing the rate of synthesis, as shown in Fig. 1. Benzimidazole was slightly inhibitory, but the effects were very variable. The pyrimidine analogues 5-nitrouracil, 5-bromouracil, 2-thiouracil and isocytosine were without effect on β -galactosidase formation. The inhibitory activity of 8-azaguanine could be completely reversed by the addition to the system of either guanine, xanthine or hypoxanthine, but not by uracil, thymine or adenine. 1 mol. of guanine annuls the inhibitory action of approximately 200 mol. of 8-azaguanine. Inhibition by 2:6-diaminopurine was partially reversed by the addition of hypoxanthine but not other purines or pyrimidines.

When *Staph. aureus* is supplied with ¹⁴C-uracil, newly formed nucleic acids are found to be radioactive, activity being localized in uracil, thymine and cytosine. During induced enzyme formation, there is a synthesis of ribo- and deoxyribo-nucleic acids which can be measured by the incorporation of ¹⁴C-uracil into the two nucleic acid fractions. Concentrations of 8-azaguanine which completely prevent β -galactosidase formation have no inhibitory activity on the synthesis of either ribo- or deoxyribo-nucleic acids, as measured by the incorporation of ¹⁴C-uracil into the pyrimidines.

Matthews³ has shown that 8-azaguanine is incorporated into the nucleic acid of tobacco mosaic virus with a resulting decrease in infectivity of the virus. Cells of *Staph. aureus* in which the induced formation

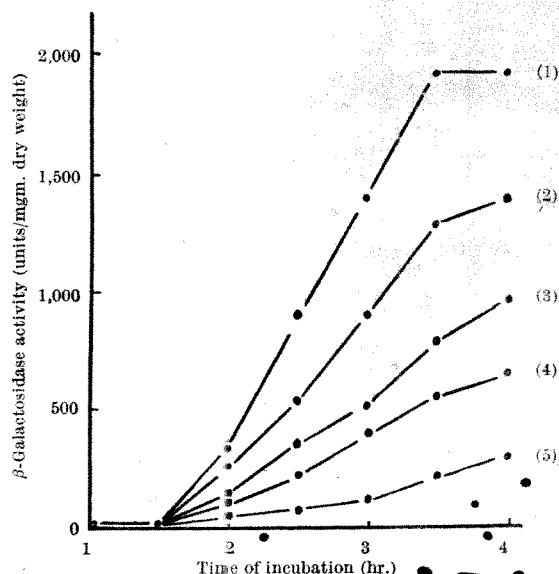


Fig. 1. Effect of 8-azaguanine and 2:6-diaminopurine on β -galactosidase formation. System consisted of *Staph. aureus* (2 mgm./ml.), 17 amino-acids (200 μ gm./ml. of each), glucose (1 mgm./ml.), galactose (20 mgm./ml.) in a buffered salts solution. Additions: (1) nil; (2) 8-azaguanine (500 μ gm./ml.); (3) 8-azaguanine (10 μ gm./ml.); (4) 8-azaguanine (20 μ gm./ml.); (5) 8-azaguanine (50 μ gm./ml.)

of β -galactosidase has been completely suppressed by 8-azaguanine have been examined by the methods described by Matthews, and it has been found that 8-azaguanine has been incorporated into ribo- but not deoxyribo-nucleic acid. It has been suggested that nucleic acid is concerned in the formation of induced enzyme^{2,4}; the present findings are consistent with that suggestion, as incorporation of 8-azaguanine into the nucleic acid might be expected to impair its function equally in protein synthesis as in virus formation.

E. H. CREASER

Medical Research Council Unit
for Chemical Microbiology,
Department of Biochemistry,
University of Cambridge.

¹ Creaser, E. H., *J. Gen. Microbiol.*, **12**, 288 (1955).

² Gale, E. F., and Folkes, J. P., *Nature*, **173**, 1223 (1954).

³ Matthews, R. E. F., *J. Gen. Microbiol.*, **10**, 521 (1954).

⁴ Pardee, A. B., *Proc. U.S. Nat. Acad. Sci.*, **40**, 263 (1954).

Bacterial Utilization of Cyanide

DURING experiments to determine the fate of potassium cyanide contained in sewage during treatment on percolating filters, a bacterium was isolated capable of growing on silica gel medium containing only potassium cyanide as a source of nitrogen and carbon; traces of iron, copper and phosphate were also present. The organism, which consisted of Gram-positive branching filaments approximately 1 μ in diameter, some of which were broken up into bacillary segments, grew on solid medium as a hard, white and powdery colony reaching a maximum of 1 mm. in diameter after incubation for seven days at 28° C. Aerial hyphae and conidia are present (Fig. 1); but the latter are probably not true reproductive bodies as the organism is killed by drying. The organism is aerobic and a strict autotroph, growth being inhibited in culture by the presence of agar or peptone. It can utilize concentrations of cyanide up to 15 mgm. per 100 ml., but appears to grow best on cyanide concentrations of approximately 4 mgm. per 100 ml. The bacterium was difficult to culture, growth being

slow and sparse; but it exhibited surprising activity, a few colonies being able to utilize more than 0.5 mgm. cyanide per day.

Ammonia is produced, apparently quantitatively, from cyanide by the growth of the organism; the fate of the carbon is not yet known.

The organism has been provisionally classed among the Actinomycetaceae, and investigation of its biochemical activity is proceeding.

G. C. WARE

H. A. PAINTER

Water Pollution Research Laboratory,

Elder Way,

Stevenage, Herts. Jan. 12.

Vaginal Sulphydryl and Disulphide Groups during the Oestrous Cycle of the Mouse

KERATINIZATION of the vaginal epithelium of the mouse occurs during the oestrous cycle. In view of the regular periodicity of this process, it was thought profitable to examine some of its associated histochemical characteristics. The occurrence of —SH and —SS groups in the oestrous vaginal epithelium of the rat has been previously noted¹. No record of the variations in the distribution of these groups during the normal oestrous cycle appears to exist.

Vaginae were removed from thirty white mice and fixed for 24 hr. in a solution of 1 gm. trichloroacetic acid dissolved in 100 ml. of 80 per cent alcohol; they were embedded in paraffin and sectioned at 7 μ . The stages of the cycle were determined from M.F.4 (Gurr's vaginal smear stain) and haematoxylin and eosin preparations in accordance with the description and terminology of Allen². Sulphydryl and disulphide groups were demonstrated by the Barnett and Seligman³ and the Chèvremont and Frédéric⁴ ferrieyanide procedures. The ferrieyanide procedure was adapted to the study of —SS groups by comparing preparations, previously reduced with thioglycolic acid⁵, with corresponding —SH group preparations (C. W. M. Adams, personal communication). Controls were incubated for 3 hr. in saturated aqueous mercuric chloride to inhibit —SH groups.

At the beginning of dioestrus, slight positive reaction for the —SH group was found in the cytoplasm of all epithelial cells; this was most marked in the basal layer. The nuclei showed a negative reaction. During later dioestrus, the most intense —SH group positivity was found in the deepest two to three layers of the epithelium; the superficial layer of cells showed no reaction, although between them there was a definite positive reaction (Fig. 1). These superficial cells do not become keratinized, but remain throughout prooestrus and early oestrus as the 'swollen' cells of the vaginal wall⁶. No —SS groups could be detected throughout the dioestrous phase. In early prooestrus the deepest seven to eight layers of the epithelium showed slight —SH group reactivity, while the superficial cells, as in late dioestrus, showed no reaction. The intermediate zone of squamous transformation showed intense localization of —SH groups and was also characterized by the first appearance of —SS group reaction; as this zone becomes keratinized during later prooestrus, the stratum corneum so formed showed an intense concentration of —SS groups. The corneum and deep layers of the late prooestrous epithelium reacted weakly for —SH groups, while the two layers

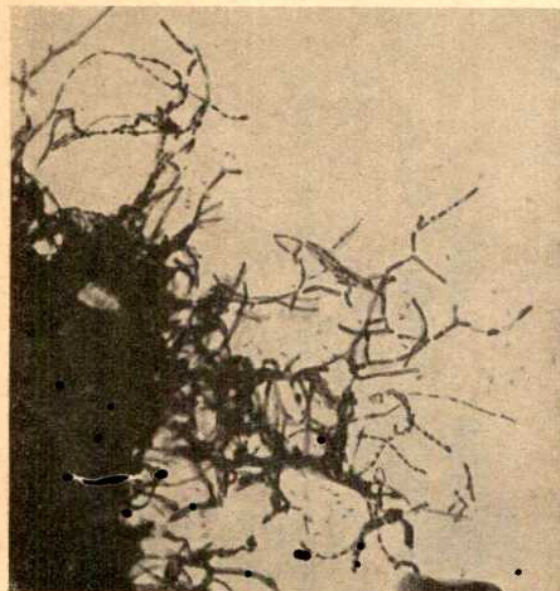


Fig. 1



Fig. 1. Distribution of —SH groups in the mid-dioestrous vaginal epithelium. $\times 100$. Barnett and Seligman procedure

Fig. 2. Distribution of —SH groups in the early oestrous vaginal epithelium. $\times 50$. Barnett and Seligman procedure

of cells immediately beneath the corneum showed intense reaction. The oestrous epithelium showed an intense —SH group reaction in the stratum granulosum; the deeper layers and the corneum were weakly positive (Fig. 2). The —SS group reaction was most intense in the corneum; the stratum granulosum showed slight reactivity. The metoestrous epithelium, following the desquamation of the superficial layers of the epithelium, showed a weak —SH group reaction throughout the cytoplasm of all epithelial cells; no —SS groups were found.

These observations indicate that cyclical variations in the distribution of —SH and —SS groups occur during the oestrous cycle of the mouse. It appears that —SH groups accumulate in the basal layers of the epithelium during dioestrus; later they are found in greatest concentration in the zone of squamous transformation of the early prooestrous epithelium, prior to keratinization during later prooestrus. The present observations further support the well-known concept of a conversion of —SH to —SS groups in the process of keratinization. Experimental and comparative studies are now in progress to elucidate whether or not hormonal factors control these cyclical variations in the distribution of —SH and —SS groups.

We are grateful to Mr. R. Quinton Cox for the preparation of the photomicrographs.

A. W. ASSCHER
C. J. TURNER

Anatomy Department,
London Hospital Medical College,
Turner Street, London, E.1.
Jan. 13.

¹ Barnett, R. J., *J. Nat. Canc. Inst.*, **13**, 905 (1953). Barnett, R. J., and Seligman, A. M., *J. Nat. Canc. Inst.*, **14**, 769 (1954).

² Allen, E., *Amer. J. Anat.*, **39**, 297 (1922).

³ Barnett, R. J., and Seligman, A. M., *Science*, **116**, 323 (1952).

⁴ Chèvremont, M., and Frédéric, J., *Arch. de Biol.*, **60**, 79 (1943).

⁵ Biggers, J. D., *J. Anat., Lond.*, **87**, 327 (1953).

Experimental Evidence for an Enzymatic Basis for Itching in Man

THE sensation of itching has long been a physiological enigma. Whereas the sensations of pain, touch, heat and cold have always arisen following simple physical stimuli, itching (pruritus) has consistently shown an indifferent response to these physical stimuli, and but a faint answer to chemical stimuli. No one has truly characterized the adequate stimulus for itching. As a result of this, itching has been denied its role as the fifth sensation. Indeed,

it has been defined by some as a diminutive pain, despite the clinical experience that itch may exceed severe pain in intensity.

The present communication describes a highly specific and presumably physiological method of evoking itching, demonstrating it as a primary sensation, distinct from pain, engendered, not by physical modalities, but by chemical stimuli. In this work the proteolytic enzymes have been found to be the true stimulus for itching.

The investigation began with a demonstration that the active pruritogenic principle of cowhage is a proteinase, mucunain¹. This led to a study of the role of enzymes in cutaneous sensation. Both crystalline and crude enzymes were introduced into the epidermis in ultra-microquantities, using a single cowhage trichome insertion technique. In this procedure, initial inactivation of the trichomes was achieved by autoclaving at 250° C. for 30 min. The trichomes were then soaked in enzyme solutions, in a dilution ranging from 10⁻¹ to 10⁻⁴, and later air-dried. The impregnated trichome was introduced manually, using a watchmaker's forceps and a 30 $\times$ magnification. The insertion of a single spicule containing active enzyme elicited a distinct mild to intense localized itch, in the absence of any urticaria or other clinical signs. This technique thus avoided the misleading vascular reactions which develop upon ordinary intradermal injection of material. Nevertheless, itching did occur whenever these active agents were injected intradermally (No. 30 needle, 0.02 ml. 10⁻³ to 10⁻⁴ dil.). Using a wide variety of enzymes, it was found that only members of the proteinase group were active as chemical excitants of itching. Furthermore, only the endopeptidases with activities in the physiological pH range showed activity. Exopeptidases, as well as endopeptidases with a pH range less than 4 (for example, pepsin), were ineffective, as is seen in the following table:

ACTIVE PROTEASES		INACTIVE PROTEASES
Plant	Animal	Pepsin*
Mucunain	Trypsin*	Carboxypeptidase*
Papain*	Chymotrypsin*	Amiriopeptidase (Leucine)
Bromelain	Pancreatin	Carnosinase
Ficin		Rennin
Fungal proteinase		
OTHER INACTIVE ENZYMES		
Acid phosphatase	Dehydrogenase, glucose-	Lipase
Alkaline phosphatase	6-phosphate	Maltase
α -Amylase	Deoxyribonuclease	Peroxidase
β -Amylase*	Emulsin	Phosphorylase
D-Amino oxidase	β -Galactosidase	Pectinase
Arginase	β -Glucosidase	Ribonuclease
Carbonic anhydrase	β -Glucuronidase	Tyrosinase
Catalase	Emicellulase	Urease
Coccarboxylase	Exokinase	Uricase
Cozymase	Lactase	

The crystalline preparations studied have an asterisk. The most active enzymes (mucunain, papain and chymotrypsin) produced itching with the shortest latent period (5 sec.) and the longest duration (30 min.). Increasing the concentration of the enzyme solutions in which the spicules were soaked decreased the latent period and increased the duration and intensity of action. Pain was never observed in any of our experiments.

The mechanism of the pruritogenic action of the proteolytic enzymes is unknown. The enzymes may have a direct effect on the nerve receptor, or may act indirectly by synthesizing or releasing an active compound from the epidermal cells. The long latent period suggests the latter as the more likely. One series of experiments was done, however, indicating that the release of histamine is not the cause of itching, despite the fact that proteolytic enzymes, for example, papain, may act as histamine liberators². It was found that histamine and the potent histamine liberator, '48/80', never produced itching in the absence of whealing. Even in the presence of confluent whealing, the itching produced was never severe. In contrast, all the active endopeptidases invariably elicited the pure sensation of intense itching without any wheal or flare.

Study of our results leads us to postulate that the release of intracellular proteinases (cathepsins) from the epidermis or elsewhere plays a significant part in itching. High levels of proteinases or low levels of inhibitory factors³ may explain itching in systemic disease or in various dermatoses.

It seems reasonable to assume that new loci of attacks have been disclosed for the pharmacologist seeking an effective antipruritic agent. Many of the quasi-effective therapies of to-day (for example, antihistaminics, sulphapyridine and arsenicals) could depend upon a partial inhibition of proteinases. The methods of enzymology may point the way to a truly specific means of temporarily blocking the proteases and therewith pruritus.

ROBERT P. ARTHUR
WALTER B. SHELLEY

Department of Dermatology,
University of Pennsylvania,
Philadelphia, Pennsylvania.
Jan. 14.

¹ Shelley, W. B., and Arthur, R. P., *Science* (in the press).

² Rocha e Silva, M., and Andrade, S. O., *J. Biol. Chem.*, **149**, 9 (1943).

³ Beloff, A., *Biochem. J.*, **40**, 108 (1946).

Amino-Acid Composition of Four Different Kinds of Human Haemoglobin

THE following haemoglobins from human blood are known at present: normal adult (*A*), foetal (*F*), sickle cell (*B*), and *C*, *D*, *E* and *G*. The most useful method of distinguishing between these haemoglobins is based on their different electrophoretic mobilities, while some of them also have other characteristic properties such as high resistance to alkali (*F*) and low solubility (*B*). The amino-acid composition of the different haemoglobins has been discussed in recent years; thus Schroeder *et al.*¹ found that the amino-acid composition of carboxyhaemoglobin-*A* and *B* was about the same, and van der Linden² described differences in the amino-acid composition of globins prepared from blood of normal adults and from cord blood³.

The present work deals with the estimation of the amino-acid composition of four different haemoglobins (*A*, *B*, *C* and *F*). These haemoglobins were prepared from blood of normal adults (*A*), from cord blood after removing the adult component by treatment with alkali by Chernoff's method⁴ (*F*), from the blood of patients with sickle cell anaemia (*B*) and from the blood of patients with the homozygous haemoglobin-*C* disease (*C*). These four haemoglobins were electro-

Table 1. AMINO-ACID COMPOSITION OF 48 HR. HYDROLYSATES OF FOUR DIFFERENT KINDS OF HUMAN CARBOXYHAEMOGLOBIN (GM./100 GM. PROTEIN)

Amino-acid	COHb-A	COHb-F	COHb-B	COHb-C
Aspartic	10.50	10.26	10.51	10.34
Threonine	5.40	6.51	5.86	5.59
Serine	4.46	5.33	4.56	4.35
Glutamic	7.25	7.65	7.16	7.21
Proline	4.96	4.22	4.64	5.06
Glycine	4.54	4.60	4.25	4.47
Alanine	9.96	9.68	9.87	9.81
Cystine/2	0.99	0.97	1.03	1.04
Valine	10.91	9.51	10.85	10.79
Methionine	1.40	1.84	1.23	1.36
Isoleucine	0.33	1.84	0.38	0.33
Leucine	15.16	15.29	15.06	14.81
Tyrosine	3.85	3.18	3.85	3.87
Phenylalanine	7.83	7.87	8.11	7.98
Lysine	9.89	9.86	9.70	10.86
Histidine	8.31	7.38	8.32	8.61
Arginine	3.36	3.34	3.33	3.41
Total*	109.19	109.83	108.71	109.89
Nitrogen recovered (per cent)*	91.8	91.4	90.2	93.1

* Without haem, tryptophan and amide nitrogen.

phoretically pure. Acid hydrolysates of these haemoglobins, made by boiling under reflux 150 mgm. of carboxyhaemoglobin in 200 ml. of 6 *N* hydrochloric acid for 48 hr., were chromatographed on ion exchange columns as described by Stein and Moore⁵.

The results of these amino-acid analyses are given as a mean of four determinations of the same number of separately prepared samples for each haemoglobin (Table 1). During acid hydrolysis, however, some destruction of some of the amino-acids occurs⁶; for example, serine (about 17 per cent), tyrosine (about 12 per cent), threonine and methionine (about 11 per cent) and lysine (about 7 per cent). The values given in the table are not corrected for these losses.

On comparing the amino-acid composition of carboxyhaemoglobin-*A* and *F*, we find that there are differences in the percentages of many amino-acids. Threonine, serine, methionine, isoleucine and perhaps glutamic acid are present in higher concentrations in the foetal haemoglobin, whereas proline, valine, tyrosine, histidine and perhaps alanine are present in smaller amounts. One of the most striking differences in the amino-acid composition of haemoglobin-*A* and *F* is the much higher content of isoleucine in the foetal pigment. Calculated as number of residues per 68,000 mol. weight, carboxyhaemoglobin-*F* contains ten residues of isoleucine, whereas only two residues of this amino-acid are present in the adult component. The absence of significant differences between carboxyhaemoglobin-*A* and *B* described by Schroeder *et al.*¹ was confirmed, while the amino-acid content of carboxyhaemoglobin-*C* is only different for two basic amino-acids, namely, lysine and histidine, which were found to be higher in this protein.

Regarding a possible relation between the differences in amino-acid compositions of these haemoglobins and their electrophoretic behaviour^{7,8}, it is surprising that only for haemoglobin *C* does the more basic nature of this protein contribute to its greater electrophoretic mobility in phosphate buffer solution pH 6.75. For the other two haemoglobins, *B* and *F*, which contain even fewer basic groups, the greater electrophoretic mobility may be explained by a different structure of the polypeptide chains in these proteins.

It is generally assumed that the hereditary factors which control the synthesis of the different haemo-

globins *A*, *B*, *C*, *D*, *E* and *G* are multiple alleles, while for the synthesis of foetal haemoglobin the presence of a gene at another locus is likely. The differences in the amino-acid composition of the four haemoglobins may perhaps support these hypotheses, as these differences between haemoglobin-*A* and *F* are more numerous and much greater than those between haemoglobin-*A* and *B* or *C*, the amino-acid compositions of which are, with the exception of a few basic amino-acids in *C*, about the same.

A detailed description of this work will be given elsewhere. We are indebted to Dr. A. van der Sar (Curaçao) for blood samples of patients with sickle cell anaemia and with the homozygous haemoglobin-*C* disease, and to Dr. T. H. Scheinberg (New York) for a sample of pure haemoglobin-*C*. This work was supported by a grant from the Netherlands Organization for Pure Research (Z.W.O.).

T. H. J. HUISMAN
J. H. P. JONXIS
P. C. VAN DER SCHAAF

Department of Pediatrics,
University of Groningen.
Jan. 19.

¹ Schroeder, W. A., Kay, L. M., and Wells, I. C., *J. Biol. Chem.*, **187**, 221 (1950).

² Linden, A. C. van der, thesis, Amsterdam (1949).

³ Dustin, J. P., Schapira, G., Dreyfus, J. C., and Hestermans-Medard, O., *C.R. Soc. Biol.*, **148**, 1207 (1954).

⁴ Chernoff, A. I., *Blood*, **8**, 399 (1953).

⁵ Moore, S., and Stein, W. H., *J. Biol. Chem.*, **211**, 893 (1954).

⁶ Schaaf, P. C. van der, and Huisman, T. H. J., *Biochim. Biophys. Acta* (in the press).

⁷ Zinsser, H. H., *Arch. Biochem. and Biophys.*, **38**, 195 (1952).

⁸ Itano, H. A., and Neel, J. V., *Proc. U.S. Nat. Acad. Sci.*, **26**, 613 (1950).

Chromatographic Estimation of Different Kinds of Human Haemoglobin

ION-EXCHANGE resins, especially 'Amberlite IRC-50', have recently been used for the purification of proteins¹⁻⁵; with the aid of this cation exchanger, two different haemoglobins, foetal sheep and bovine carboxyhaemoglobin, could be separated⁶. Extending these experiments to human haemoglobin, we developed two methods for the separation and quantitative estimation of four different kinds of human haemoglobin, namely, carboxyhaemoglobin-*A* (adult), *B* (sickle cell), *C* and *F* (foetal).

In our first method (elution method), which is in general the same as described by Boardman and Partridge⁶, the cation exchanger 'Amberlite IRC-50 (XE-64)', pretreated as described by Hirs *et al.*², was used. The best separation of the four different haemoglobins investigated was obtained at pH 6.50 (citrate buffer with a constant amount of citric acid and different sodium ion concentrations). Under these experimental conditions, foetal haemoglobin is practically not absorbed. The separation of carboxyhaemoglobin-*F* and *A* is improved by a relatively low rate of flow of the effluent. Fig. 1 shows the chromatogram of the four different haemoglobins using a column of 'Amberlite IRC-50 (XE-64)' of 13 cm. × 0.9 cm. at 10° C. The separation of the components of the haemoglobin mixture is quite good. The yields were about 85 per cent at 10° C., but could be improved by working at lower temperatures.

The second method (cuvette method) is a simplification of the first. The 'column' used consists of a flat cuvette ('Lucite') of 3.0 cm. × 0.5 cm. × 20 cm., which is filled up to 15 cm. with 'Amberlite

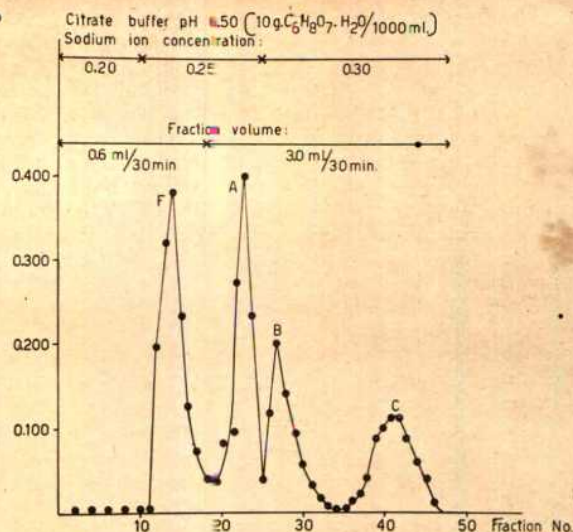


Fig. 1. Elution curves of four different kinds of human haemoglobin, chromatographed on 'Amberlite IRC-50 (XE-64)'. 48.5 mgm. carboxyhaemoglobin (in 0.5 ml.) was chromatographed; from each fraction, after dilution to 4 ml., the extinction was measured at 5700 Å. Temp., 10° C.; recovery 85 per cent. The carboxyhaemoglobins are indicated by *F* (foetal); *A* (adult); *B* (sickle cell); and *C*

IRC-50 (XE-64)'. About 10–15 mgm. carboxyhaemoglobin (in 1.0 ml.) is chromatographed using a sodium citrate-citric acid buffer (sodium ion concentration 0.15) of pH about 6 at 0° C. After the elution of 200 ml. effluent, siphoned into the cuvette at a rate of about 20 ml. per hr., a good separation of the four components is obtained (Fig. 2). The mean rates of displacement are quite different for each component and are in the proportions of 1.33 (*F*): 1.00 (*A*): 0.72 (*B*): 0.34 (*C*). The amounts of the haemoglobins present in the mixture are estimated by measuring a diapositive of the cuvette according to the method of Grassmann and Hannig⁷. The

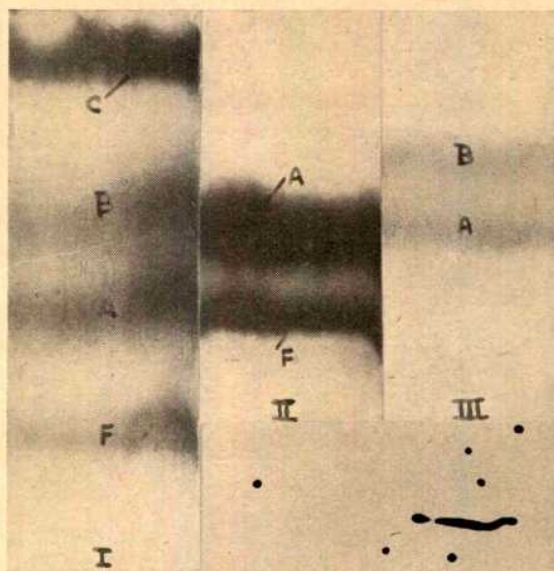


Fig. 2. Chromatographic separation of different haemoglobins by the cuvette method. I: artificial mixture of four different haemoglobins (200 ml. effluent was eluted); II: haemoglobin of a patient with Cooley anaemia (100 ml. eluted); III: haemoglobin of a patient with a sickle cell trait (100 ml. eluted)

Table 1. PERCENTAGE ESTIMATION OF FOETAL HÆMOGLOBIN IN MIXTURES OF CARBOXYHÆMOGLOBIN A AND F ESTIMATED BY THE TWO CHROMATOGRAPHIC METHODS AT 0°C.

Sample No.	Calculated	Elution method	Cuvette method
1	83.5*	85.5; 84.0†	91.5; 91.5
2	72.5	75.0; 73.0	79.0; 77.5
3	59.0	56.5; 61.5	61.0; 61.0
4	42.5	43.5; 43.5	49.5; 47.5
5	24.0	23.0; 29.5	22.0; 19.5
6	12.0	17.0; 12.5	12.5; 12.5

* Estimated by the alkali denaturation method of Brinkman and Jonxis (ref. 8); the percentages of carboxyhaemoglobin F in the other five samples were obtained by dilution with normal adult carboxyhaemoglobin.

† Duplicate estimations.

method can be carried out in a normal refrigerator with a larger number of cuvettes simultaneously.

As regards quantitative results, it is found (Table 1) that in general they are in good agreement with the calculated values. With the elution method, there is a deviation of about 2 per cent, whereas the cuvette method shows a slightly higher error, especially at low concentrations of one of the components.

The methods described here may be of value for the determination of relatively low percentages (less than 10 per cent) of foetal haemoglobin, as the separation of this pigment from the other haemoglobins is good even at small concentrations. Moreover, the elution method has the advantage that an abnormal haemoglobin can be eluted free of other pigments and used for further research.

A full account of this work will be given elsewhere. We wish to thank the Rohm and Haas Company (Philadelphia 5, Pennsylvania) for a gift of 'Amberlite IRC-50 (XE-64)'. The investigations were supported by a grant of the Nutricia Co., Zoetermeer, The Netherlands.

H. K. PRINS
T. H. J. HUISMAN

Department of Pediatrics,
University of Groningen.
Jan. 19.

* Tallan, H. H., and Stein, W. H., *J. Biol. Chem.*, **200**, 507 (1953).

† Hirs, H. W., Moore, S., and Stein, W. H., *J. Biol. Chem.*, **200**, 493 (1953).

‡ Hirs, H. W., *J. Biol. Chem.*, **205**, 93 (1953).

§ Margoliash, E., *Biochem. J.*, **56**, 529 (1954).

|| Boman, H. G., *Nature*, **173**, 447 (1954).

¶ Boardman, N. K., and Partridge, S. M., *Nature*, **171**, 208 (1953).

‡ Grassmann, W., and Hannig, K., *Hoppe Seyler's Z. physiol. Chem.*, **209**, 1 (1952).

§ Brinkman, R., and Jonxis, J. H. P., *J. Physiol.*, **55**, 117 (1955); **55**, 162 (1956).

Nature of the Cuticle of Pycnogonida

RECENT work has tended to show that, in spite of differences in structural features, the cuticle of insects conforms to a basic pattern in consisting of an inner protein-chitin endocuticle and an outer non-chitinous lipoprotein layer bounded externally by a very thin lipid membrane¹. Although the cuticle of other groups of Arthropoda are not known in such detail as in insects, previous work indicates that in general the pattern in them may not be unlike that in insects. However, in the mode of hardening of the cuticle marked differences have been noted. While in insects the hardening is by phenolic tanning, in crustaceans, though the cuticle is initially hardened

to some extent by phenolic tanning, the prime cause of hardening is by calcification². In arachnids such as *Limulus*³ and *Palamneus*⁴ there is evidence of the occurrence of hardening by sulphur linkages. Although the significance of such a mode of hardening in the above-mentioned types is not clear, it appears that it may be more common than has hitherto been suspected. It is therefore of interest to find in the cuticle of *Propallene kempi*, a common pycnogonid of Madras, evidence to suggest the occurrence of disulphide linkages which are probably involved in the hardening of the cuticle.

Transverse sections of the cuticle show an inner layer marked by horizontal lamellations and traversed by dermal gland ducts, and a very thin, apparently homogeneous, outer layer bounded by a very thin dark membrane. These two layers correspond to the epi- and endo-cuticle of insects. With Mallory's triple stain, the endocuticle turns a blue colour while the epicuticle is unstained. With Heidenhain's haematoxylin also the epicuticle did not take up the stain; but the endocuticle took up a faint brown coloration. From the chitosan and Schultze's tests it is inferred that the endocuticle contains chitin and the epicuticle is devoid of it. By prolonged treatment with chlorated nitric acid the epicuticle may be separated from the endocuticle, which does not survive the above treatment. Both the epicuticle and endocuticle are not positive to Millon's and the xanthoproteic tests, while only the outer dark membrane gives a positive reaction to the argentaffin test. This membrane is also positive to sudan black B. The chemical features indicated by the above tests strongly recall those of the epicuticle of *Palamneus*^{4,5}. The similarity is further emphasized by the positive reaction to tests for organic sulphur. The unstained region of the epicuticle is reactive to the thioglycollate test, which is further confirmed by the positive reaction to alkaline lead acetate; this turns the uncoloured inner epicuticle to a deep brown or black. With alkaline sodium sulphide the cuticle undergoes marked softening, and sections of such material when stained with Mallory's triple stain show that the inner epicuticle, which in untreated sections is non-staining, now becomes reactive to stains. But unlike the epicuticle of other arthropods, which invariably stains red with acid fuchsin of the Mallory, the epicuticle of the pycnogonid takes up a blue colour like the endocuticle. The absence of a differential staining of the epi- and endo-cuticle in Mallory by which the two layers are usually distinguished in other arthropods is remarkable.

From the observations reported above, it may be inferred that the epicuticle is hardened by disulphide bonds as in *Palamneus swammerdami*, and treatment with alkaline sodium sulphide results in a breaking up of the bonds and the consequent resumption of the ability to take up stains, similar to the effect produced by diaphanol on cuticle hardened by phenolic tanning. A fuller account of this work will be published elsewhere.

G. KRISHNAN

Department of Zoology,
University of Madras.
Dec. 23.

¹ Dennell, R., and Malek, S. R. A., *Nature*, **171**, 298 (1953).

² Dennell, R., *Proc. Roy. Soc., B*, **134**, 485 (1947b). Krishnan, G., *Quart. J. Micr. Sci.*, **92**, 333 (1951).

³ Lafon, M., *Bull. Inst. Oceanogr. Monaco*, No. 850 (1943).

⁴ Krishnan, G., *Quart. J. Micr. Sci.*, **94**, 11 (1953).

⁵ Krishnan, G., *Quart. J. Micr. Sci.*, **95**, 371 (1954).

Meiosis in *Furcellaria fastigiata* (L.) Lamour.

THE tetrasporangium of *Furcellaria fastigiata* (L.) Lamour. remains uninucleate for five months or more before the tetraspores are formed. The meiotic divisions then take place rapidly throughout the numerous sporangia and have been observed at Aberystwyth between November 9 and 15.

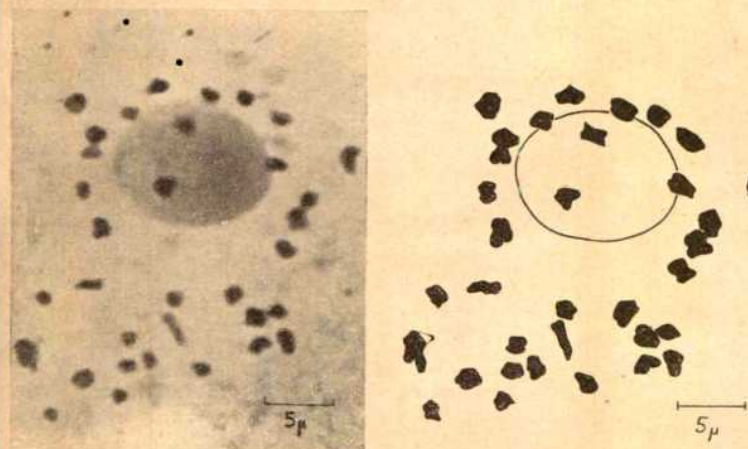


Fig. 1. Diakinesis in the tetrasporangium of *Furcellaria fastigiata* (L.) Lam. (a) Photomicrograph of nucleus. (b) Camera lucida drawing. The large 'bivalent' referred to in the text is towards the lower left of the figure

Owing to the inaccessibility of the plant on the sea-shore, except at low water of spring tides, the plants were kept in tanks in order to observe the nuclear divisions. They remained quite healthy in fresh aerated sea water when placed in subdued light. Nuclei in division were found most frequently between 9.00 p.m. and 12.00 midnight, corresponding approximately with high water in the neighbourhood.

The nuclei were observed by using a modification of the alum-acetocarmine squash technique¹ after fixation in acetic-alcohol or Carnoy's fluid (from unpublished information communicated by K. R. Lewis, Department of Botany, University College, Cardiff). Formalin-acetic-alcohol² also gave good results and enabled spindles to be more clearly seen.

Early prophase nuclei, before chromosome duality, clearly show distinct thread-like chromosomes independent of the nucleolus, which is single and persists until the end of diakinesis. Chromomeres are conspicuous on the uncontracted prophase chromosomes. Subsequent stages lead rapidly through pairing to early diplotene and then diakinesis, in both of which the haploid count appears to be $n = 34$, or possibly 35, doubt being centred about one bivalent of larger dimensions than the others. The diakinesis is prolonged; most of the chromosome pairs show two chiasmata, while possibly two pairs show one, and one or two show three. Fig. 1 shows a typical diakinesis in the tetrasporangial nucleus.

The distribution of the chromosome pairs in the nucleus changes markedly between diakinesis and metaphase proper, constituting a short prometaphase, during which the highly contracted bivalents shift from their peripheral diakinetid position to form a roughly equatorial cluster around degenerating

nucleolar fragments in the centre of the nucleus. On the metaphase plate the bivalents are even more contracted, and two dense more-or-less ring-shaped bunches of small globular chromosomes separate at anaphase. The faint but definite spindle appears to be anastral and has its axis orientated obliquely to the longitudinal axis of the sporangium.

In the daughter nuclei reconstruction occurs, the chromosomes become de-spiralized and secondarily associated to some extent, nucleoli form, and an almost complete resting state is assumed. An incipient wall is initiated before early anaphase, and its formation—thought to involve a phragmoplast—is quite advanced before the second meiotic divisions occur. The latter are not as simple to observe, the chromosomes are smaller after splitting, and metaphase and anaphase often seem a little irregular. The secondary cross-walls, that is, the walls dividing the products of the second division into the four zonate spores, begin to form prior to this division. The spindles of the second division are arranged approximately with their axes along a pair of opposite edges of a tetrahedron.

A detailed account of this work will be published elsewhere.

A. P. AUSTIN

University College of Wales,
Aberystwyth.
Jan. 20.

¹ Godward, M., *Ann. Bot.*, N.S., 14, No. 53 (1950).

² Westbrook, M. A., *Sonderabdruck aus Beihefte zum Bot. Centralbl.*, 53, Abt. A (1935).

Golgi Bodies in the Spermatogenesis of Pulmonate Gastropods

Nath and Chopra have recently completed investigations on the spermatogenesis of the Simla slug, *Anadenus altivagus* (Theobald). This material has unexpectedly turned out to be an excellent material for the demonstration of (1) the origin of Golgi dictyosomes from the mitochondrial granules by alignment, and (2) the secretion of the acrosome by the dictyosomes. These workers have also examined the living material under the phase-contrast microscope.

In the earliest spermatogonia of *Anadenus* there is no indication of any granulation, the cytoplasm staining uniformly with iron-haematoxylin after Flemming—without acetic acid fixation. In late spermatogonia the mitochondria appear for the first time in the form of granules; but there is no indication whatsoever of the Golgi dictyosomes. It is in the earliest primary spermatocytes that the mitochondria begin to align themselves to form the Golgi dictyosomes. To begin with, the dictyosomes have a crenated appearance, but soon they assume a uniform contour. Nor is there any chromophobic vesicle attached to a dictyosome. In the fully grown primary spermatocyte the dictyosomes all collect together, and there is only one such collection to each cell.

During metaphase I, however, when the spindle, the centrioles, the chromosomes and the mito-

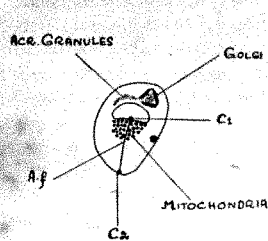


Fig. 1

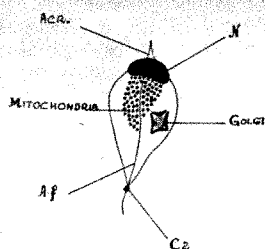


Fig. 2

chondrial granules are all brought up very clearly in the finished sections, there is no trace of the dictyosomes left. Just previous to this, in the preceding diakinesis, the dictyosomes can be clearly seen breaking up into granules, which merge into the mitochondrial granules. During late telophase I the dictyosomes are again formed by the alignment of mitochondrial granules; and during metaphase II and anaphase II, the dictyosomes again break up to merge into the mitochondrial granules, to reappear again during late telophase II.

In the course of spermateliosis and before the deposition of the acrosome, each Golgi dictyosome develops in close association with it a chromophobic vesicle. The Golgi apparatus shifts to the anterior aspect of the spermatid nucleus; and a large number of minute acrosomal granules, first seen in the chromophobic vesicles, are deposited in front of the nucleus. These granules afterwards form the acrosome, and the Golgi apparatus, having performed its function of secreting the acrosome, is sloughed off (Figs. 1 and 2).

Hirsch¹ derives the Golgi pre-substance, that is, the Golgi granules, from the mitochondria. In my view, stronger evidence than *Anadenus* in favour of Hirsch's view could not be wished for, as the Golgi dictyosomes in this material not only arise from the mitochondria but also merge into them during metaphase I and II. This material also provides strong support for the view of Hirsch that the secretion or the product arises in the internum of the Golgi complex. In support of the contention that the Golgi dictyosomes in *Anadenus* originate from the mitochondrial granules, so that to begin with the dictyosomes have a crenated appearance, reference may be made to Gatenby, ref. 2 (Fig. 24, Pl. 32) and to Watts, ref. 3 (text-figs. 4 and 5), in which the dictyosomes with a jagged contour have been figured.

All previous workers on the male germ-cells of pulmonate gastropods, with one exception, describe the Golgi element as a dictyosome. Gatenby^{2,4} on *Helix aspersa* and some other pulmonates and *Limnaea*, Hickman⁵ on *Succinea ovalis*, Baker⁶ on *Helix aspersa*, and Watts³ on *Arion subfuscus* have all described the Golgi body as a dictyosome or a banana-shaped rod associated with which is a chromophobic sphere. Again, earlier workers who studied the formation of the acrosome state that this structure is secreted by the Golgi apparatus. After secreting the acrosome, the Golgi apparatus is said to be sloughed off according to all previous accounts. But Srivastava⁷, working on *Vaginula maculata*, has described the Golgi apparatus in the male germ-cells of pulmonate gastropods as a single spherical body and not as a collection of dictyosomes; he is the only worker who has stated that "there is no connection between the Golgi body and acrosome".

It is suggested that Srivastava's Golgi body is in reality an enigmatic chromatoid body corresponding to such a body in the spermatogenesis of the domestic duck⁸ and the chequered water snake, *Natrix p. piscator*⁹. The histochemical reactions of the chromatoid bodies of the duck and the snake are exactly similar to those of the Golgi body, as described by Srivastava in *Vaginula*. Sud and Gupta have applied the specific lipid stain recommended by Baker⁶ and Thomas¹⁰, namely, sudan black, on these chromatoid bodies and have obtained negative results.

A full account of the work on *Anadenus* will be published later.

VISHWA NATH

Department of Zoology,
Panjab University,
Hoshiarpur,
Panjab.
Feb. 28.

¹ Hirsch, *Protoplasma Monographs* (Berlin, 1939), quoted by Bourne (1951).

² Gatenby, J. B., *Quart. J. Micro. Sci.*, **62**, 555 (1917).

³ Watts, H. G., *J. Morph.*, **91**, 53 (1952).

⁴ Gatenby, J. B., *Quart. J. Micro. Sci.*, **63**, 197 (1918); **63**, 445 (1919).

⁵ Hickman, C. P., *J. Morph.*, **51**, 243 (1931).

⁶ Baker, J. R., *Quart. J. Micro. Sci.*, **85**, 1 (1944); **90**, 293 (1949).

⁷ Srivastava, M. D. L., *Nature*, **172**, 659 (1953).

⁸ Gupta, B. L., *Res. Bull. Panj. Univ.* (in the press).

⁹ Sud, B. N., *Res. Bull. Panj. Univ.* (in the press).

¹⁰ Thomas, O. L., *Quart. J. Micro. Sci.*, **89**, 333 (1948).

Failure of Myxomatosis on Skokholm Island

ATTEMPTS to exterminate the wild rabbits on the Pembrokeshire island of Skokholm by various methods were described in *Nature*¹ in 1940. The late Sir Charles Martin brought the virulent strain B of the virus known as *Myxomatosis cuniculi* Sanarelli 1898 to the island in three separate attempts to induce myxomatosis in rabbits in 1936, 1937 and 1938. In each attempt the marked rabbits (inoculated with the virus) appeared to have died within the usual period of less than fourteen days; but there was little or no spread to uninoculated rabbits. At the time, the apparent failure of this virus to spread in the dense colony of rabbits on Skokholm seemed inexplicable, since the same strain had wiped out rabbits in Sir Charles Martin's enclosures (500 sq. yd.) at Cambridge in 1934-35². It is significant that before conducting these controlled experiments in the field in Cambridgeshire, Sir Charles had evidently decided that the possibility of the virus being carried to wild rabbits elsewhere by insects was too remote to constitute a public danger—a risk that would not be lightly undertaken by scientists to-day. Sir Charles believed that the disease was chiefly propagated by direct contact. We now know that contact alone is not effective, and the virus must enter the tissue of a healthy rabbit through a scratch, cut or insect bite.

The absence of fleas on the island rabbits was noticed in 1936-38; but its significance was overlooked. Sir Charles had relied upon the statement by Aragão in Brazil that the cat flea, *Ctenopsylla felis*, infesting rabbits was capable of transmitting the virus; but in view of the small number of cases in which positive results were obtained, Aragão believed that this mode of transmission was exceptional.

As the role of the European rabbit's natural flea, *Spilopsyllus cuniculi*, as chief vector of the myxoma

virus in Britain has now been established², it seemed desirable to investigate the degree of infestation by this flea of the rabbits on Skokholm, which still continue to remain unaffected by the present epidemic of myxomatosis. In the summer of 1954 the warden of Skokholm Bird Observatory examined for me thirty rabbits taken there; but could find only one flea—this was not identified and may have been a bird flea (numerous puffins and shearwaters nest in rabbit burrows on Skokholm). In March 1955 I visited Skokholm and examined a further thirty rabbits, as soon as taken alive, without finding a single flea. (Mainland rabbits show an infestation of between 0 and 270 fleas per individual.)

It seems clear that the failure of myxomatosis to spread at Skokholm was, and is, due to this absence of the virus-carrying *Spilopsyllus* flea. The absence or scarcity of this flea on Skokholm (240 acres) is in contrast with conditions on the neighbouring island of Skomer (750 acres), where on May 25, 1954, I examined three adult rabbits carrying 3, 12 and 12 fleas respectively. Myxomatosis arrived naturally on Skomer (probably via fleas carried on carrion-eating gulls which were feeding on rabbits dying of the disease on the mainland, and which were roosting the same night on Skomer—as these gulls also roost at Skokholm) in the autumn of 1954, and has since almost completely destroyed the Skomer population of at least six thousand rabbits.

As a vector, the European rabbit flea seems to be more effective in temperate climates than the various species of mosquitoes, which spread the virus in warm humid regions or weather. In Australia the European rabbit flea is unknown, and the native stickfast flea, *Echidnophaga* (from marsupials), which attaches itself to rabbits, is a much less effective vector, often perhaps in chain-transmission with the mosquito. In New Zealand, where there are no rabbit or marsupial fleas⁴, introductions of the myxoma virus have generally failed in spite of numerous indigenous biting mosquitoes and sand-flies⁵.

R. M. LOCKLEY

The Nature Conservancy,
19 Belgrave Square,
London, S.W.1.

¹ *Nature*, 145, 767 (1940).

² Martin, C. J., *J. Coun. Sci. Ind. Res. Aust.*, Bull. 96 (1936).

³ Lockley, R. M., *Vet. Rec.*, 66, 434 (1954). Ritchie, J. N., Hudson, J. R., and Thompson, H. V., *Vet. Rec.*, 66, 796 (1954). Allan, R. M., and Shanks, P. L., *Nature*, 175, 692 (1955).

⁴ Bull, P. C., *N.Z. J. Sci. and Tech.*, B, 34, 341 (1953).

⁵ Filmer, J. F., *N.Z. J. Agric.*, 87, 402 (1953).

Effect of 'Tobacco Leaf-Curl' and Tobacco Mosaic Virus on the Amino-acid and Amide Content of *Nicotiana* sp.

THE results of Martin, Balls and McKinney¹, Meneghini and Delwiche², Commoner *et al.*³ and others have shown that virus synthesis is associated with a remarkable increase in the soluble protein content of *Nicotiana* leaves infected with tobacco mosaic virus. Takahashi and Mamoru⁴, and Commoner *et al.*⁵, have resolved and isolated a new protein from virus-free extracts of mosaic tobacco leaves, which was not detected by Wildman, Cheo and Borner⁶, by electrophoresis. A study of free and hydrolysed protein of both healthy and virus-infected leaves, by a modified technique of horizontal paper chromatography, has revealed the absence of a ninhydrin-reacting sub-

stance (present in healthy leaves) from the water extract of leaves infected with tobacco mosaic virus and leaves infected with tobacco curl virus. Further, the water-soluble extracts of diseased leaves revealed the presence of two new bands corresponding to asparagine and histidine-lysine.

The leaves were extracted with hot water, and the hydrolysate prepared by hydrolysing the residue of the plant material with 6 N hydrochloric acid and autoclaving at 15 lb. pressure for 2 hr. The solutions were centrifuged at 2,000 revolutions per minute and the clear supernatant liquid was spotted on their respective places for the separation and identification of the amino-acids.

To eliminate any overlapping of the adjacent bands⁷, thus making quantitative estimations⁸ more reliable, and also to keep a number of solutions on the same paper⁹, a modification made by Ranjan *et al.*¹⁰ proved to be the most successful one. Whatman filter paper No. 1 of 40 cm. diameter having sixteen equal sectors separated by sixteen radial cuts was used in the present investigation. Reference solutions were placed at four different points to facilitate identification of the bands. The method used incorporates the advantages of both circular paper chromatography and strip-paper chromatography. A single sector may be compared to a strip; radial flow of the solvent is maintained and the amino-acids appear in arcs instead of spots.

The chromatogram was run with butanol/acetic acid/water (4:1:5) for 8 hr. using a single paper wick (2 cm. × 4 cm.) in the centre. The solvent front was marked, the paper dried at room temperature (24° ± 1° C.) and sprayed with 0.1 per cent ninhydrin in acetone. Bands were allowed to develop for 4 hr. at room temperature and then at 70° C. for 10 min.

The acid hydrolysate of both healthy and diseased leaves revealed the same range of amino-acids: leucine and isoleucine (*R_F* 0.83), phenylalanine (0.76), valine and methionine (0.69), tyrosine (0.62), alanine (0.50), glutamic acid and threonine (0.44), glycine and aspartic acid (0.34), arginine (0.24), and histidine and lysine (0.20). Tryptophan could not be detected as it is destroyed by hydrochloric acid.

In the case of the water-soluble or free amino-acids, it was observed that the concentration of the amino-acids, and specially of aspartic acid, showed a marked increase in the case of the virus-infected leaves, as judged by the deepness of the bands. In addition, two new bands were present in the water-soluble extracts of the diseased leaves, one corresponding to histidine-lysine (0.20) and the other to asparagine (0.28). The lowest band (*R_F* 0.065) present in the water-soluble extract of healthy leaves, which could not be identified, was absent in that from the diseased leaves. The other common free amino-acids present in the water-extracts of both healthy and diseased leaves are: tyrosine (0.62), proline (0.54), alanine (0.50), glutamic acid (0.44), aspartic acid (0.34) and serine (0.32).

The absence of threonine and glycine was established by using buffered paper and by running the chromatogram in butanol/acetic acid mixture buffered to pH 12.

The absence of the lowest unidentified band from the water-soluble amino-acids of diseased leaves suggests that it is used up in the synthesis of the virus itself, or the virus interferes in its synthesis in the host.

Knight¹¹ has reported the presence of lysine with other amino-acids in the nitrogen content of tobacco mosaic virus. It is possible that the new band having R_F value 0.20 might be the lysine of tobacco mosaic virus protein. However, the formation of asparagine and the increase in the content of other free amino-acids, specially aspartic acid, in the diseased leaves supports Bawden's view¹² that virus infection leads to the formation of a new range of proteins.

We are grateful to Prof. Shri Ranjan for his suggestions and for laboratory facilities. We thank also Sri K. S. Bilgrami for his help in autoclaving the solutions.

M. M. LALORAYA
GOVIND JEE

Department of Botany,
University of Allahabad.

¹ Martin, L. F., Balls, A. K., and McKinney, H. H., *Science*, **87**, 177 (1951).

² Meneghini, M., and Delwiche, C. C., *J. Biol. Chem.*, **187**, 177 (1951).

³ Commoner, B., and Nehari, V., *J. Gen. Physiol.*, **36** (6), 791 (1953).

⁴ Takahashi, W. N., and Mamoru, I., *Nature*, **169**, 419 (1952).

⁵ Commoner, B., Newmark, P., and Rodenberg, S. D., *Arch. Biochem. and Biophys.*, **37** (7), 15 (1952).

⁶ Wildman, S. G., Cheo, C. C., and Bonner, J., *J. Biol. Chem.*, **180**, 985 (1949).

⁷ Giri, K. V., and Rao, N. A. N., *Nature*, **169**, 923 (1954).

⁸ Giri, K. V., Krishnamurthy, K., and Vekatasubramanian, T. A., *Curr. Sci.*, **21** (2), 44 (1952).

⁹ Ganguli, N. C., *Nature*, **174**, 189 (1954).

¹⁰ Ranjan, S., Govindjee, and Laloraya, M. M., *Proc. Nat. Inst. Sci. India* (in the press).

¹¹ Knight, C. A., *J. Biol. Chem.*, **171**, 297 (1947).

¹² Bawden, F. C., *J. Sci. and Indust. Res.*, **13** (3), 106 (1954).

Extreme Resolution of Infra-Red Absorption Spectra

Rank and Wiggins have constructed an infra-red spectrometer with a plane grating of fine quality and 10-metre optics, double-passed¹.

An ideal subject with which to study the resolution was found in the l -doublets of the $\pi \rightarrow \pi$ band of hydrogen cyanide at 1.5μ . The components of these doublets are equal in intensity and their separations are proportional to the J numbers². Moreover, the separations are known, so that a distinction can be made between the conditions 'just resolved' and 'fully resolved'. When a doublet is 'just resolved', the structure is recognized but the apparent separation between the components is smaller than the true value. For example, $P(7)$ was just resolved with a measured separation of 0.072 cm^{-1} as compared with the actual value of 0.096 cm^{-1} . The closest doublets to be fully resolved were $P(15)$ and $R(9)$, the true separations of which are 0.180 cm^{-1} and 0.173 cm^{-1} respectively.

While this performance exceeded that of any other existing grating instrument, it was deemed of interest to investigate the possibility of increasing the resolution even further. Since the limit of resolution was set, not by lack of energy or by insufficient sensitivity of the detectors but by imperfections in the grating itself, nothing was to be gained by additional passes through the optical system. Indeed, since it was unlikely that gratings of substantially better quality would be produced in the near future, it was clear that improvement could not be obtained with any grating instrument alone, no matter what its design.

A method for using a Fabry-Perot interferometer in infra-red absorption studies has already been described³. The technique had been developed

originally to improve the resolution of small spectrometers; but it was superseded by the device of multiple-passing⁴. It was found to be tedious and impractical by comparison. However, the interferometer is very suitable for our present purpose.

A Fabry-Perot interferometer was crossed with the grating spectrometer. The separation of the interferometer plates was set so that the range of frequency between orders was equal to the spectral slit-width of the spectrometer, which thus served as a primary monochromator the function of which was to remove overlapping orders. If a fraction Δm of a fringe order could be resolved, then under the above conditions the resolution of the combination of the interferometer and spectrometer was as much as $1/\Delta m$ times that of the latter alone. In this way it was possible to resolve fully the doublets $P(3)$ and $R(2)$; the measured separation of $R(2)$ was 0.045 cm^{-1} . This is seen to represent a sixfold improvement if the Doppler width (0.016 cm^{-1}) of the lines is taken into account.

The effective reflectivity of the plates was 65 per cent, produced by zinc sulphide-magnesium fluoride coatings. The plate separation was 28.5 mm .

The purpose of this communication is to direct attention to the fact that it is now possible to attain a full resolving power of well in excess of 200,000 at 1.5μ . This may be near the useful limit at the present time, because of Doppler broadening of the absorption lines. Nevertheless, the system has still not reached its energy limit, and the resolution could be improved further by increasing the separation between the plates of the interferometer. Full details of the instrument will be published elsewhere.

This research was assisted by support from Contract N6onr Task V of the U.S. Office of Naval Research.

J. H. JAFFE*
T. A. WIGGINS
D. H. RANK

Physics Department,
Pennsylvania State University,
State College, Pennsylvania.
Jan. 5.

* On sabbatical leave from the Weizmann Institute of Science, Rehovoth, Israel.

¹ Rank, D. H., and Wiggins, T. A., *J. Opt. Soc. Amer.*, **42**, 983 (1952).

² Wiggins, Shearer, Shull and Rank, *J. Chem. Phys.*, **22**, 547 (1954).

³ Jaffe, J. H., *Nature*, **168**, 381 (1951).

⁴ Walsh, A., *Nature*, **167**, 810 (1951).

A Solar Noise Outburst of January 15, 1955

AN interferometer-type noise receiver has been operating at the Radio Physics Laboratory of the Research Defence Board, Canada, for more than a year. This receiver has been recording the radiation at a frequency of 50 Mc/s. from the discrete source in the constellation of Cassiopeia. However, the antenna is so constructed that solar noise will be recorded if of sufficient magnitude.

On January 15 of this year, a particularly large noise outburst from the sun was observed. The outburst commenced at 9.45 a.m. Eastern Standard Time as a single spike on our record, which lasted approximately four minutes. This was followed at 9.53 a.m. by a large increase in the noise-level lasting until 3.00 p.m. On the following day a very large burst was again observed, commencing at

4.10 p.m. and continuing until 4.30 p.m. On January 17 no outstanding events were observed on our records, but on January 18 a large burst was recorded during 3.57–4.10 p.m. The January 19 records also showed a large outburst during 8.36–9.30 a.m. In all cases the magnitude was not determined as the recording meter was driven off scale.

A study of the vertical-incidence ionospheric recorder records for Ottawa for the corresponding days indicated that an intense ionospheric storm followed the noise outbursts. The storm started about 9.00 a.m. on January 17 with spread echoes from the F_2 region and absorption conditions, followed by a sequence of low F_2 critical frequencies, blackout and sporadic E conditions. During the afternoon of that day, the ionosphere returned to near normal conditions, but during the evening very disturbed conditions were again observed. A succession of spread F_2 echoes, lower F_2 critical frequencies, increased absorption and sporadic E echoes from lower heights was observed, followed by a blackout. This storm continued through the night, and with the return of daylight a tendency towards normal was observed. By early afternoon of January 18, the ionospheric records indicated normal conditions for that time of year. On the evening of January 18 there was another ionospheric storm, but not so intense as that of the previous night. The disturbed conditions persisted into the following day, and a more severe ionospheric storm was recorded during the evening and night of January 19 than that observed on January 17. Normal conditions returned during the morning hours of January 20.

During the evening and night of January 17 a very intense auroral display was observed at several points in Canada and the United States. Observers in Churchill, Manitoba, reported a type 4 red aurora on that occasion. Intense auroral displays were also observed on the nights of January 18 and January 19.

This work was carried out under the Defence Research Board project PCC-D48-28-01-02.

T. R. HARTZ

Radio Physics Laboratory,
Defence Research Board,
Shirley Bay,
Ottawa.
Feb. 8.

Low-voltage, Short-duration Arcs between Separating Contacts in Low-voltage, Substantially Non-inductive Circuits

It was originally supposed that separating contacts in low-voltage, low-inductance circuits interrupted the current without arcing provided the supply voltage was lower than the ionization potential of the contact metal, and that the circuit inductance was not greater than about a microhenry. However, inconsistencies in the values of the measured 'fine transfer' obtained under these so-called arc-free conditions led to the supposition that arcs might be present¹, and this was confirmed by Lander², who published an oscillographic record of an arc obtained between separating gold contacts in a 6-volt, 1 microhenry circuit carrying a current of 1 ampere.

The existence of low-voltage 'short arcs' during contact closure has also been deduced from transfer and voltage measurements³, and oscillographic records of these arcs have been published⁴.

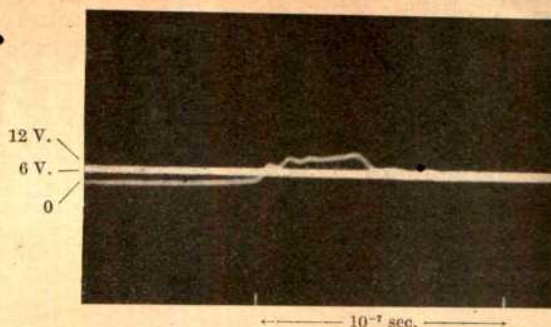


Fig. 1. Arc voltage record of separation of platinum contacts. Inductance, 0.09 μ H.; break current, 3.3 amp.; supply voltage, 6 V.

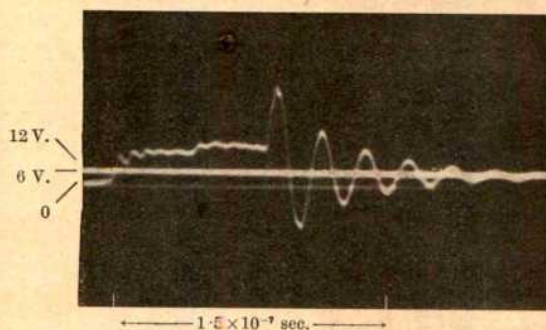


Fig. 2. Arc voltage record of separation of platinum contacts. Inductance, 0.34 μ H.; break current, 3.3 amp.; supply voltage, 6 V.

Investigations carried out by the Electrical Research Association⁵ on platinum contacts breaking a 6-volt circuit have shown that the amount of metal transfer is very dependent on the effective circuit inductance L and the current I at break for inductances between 0.06 and 117 microhenrys and currents between 1.3 and 5.6 amperes. These have led to the theory that the transfer is at least partly due to a form of 'short arc' in metal vapour between the contacts. The amount of transfer depends on the metal vapour and the available energy, $\frac{1}{2} LI^2$.

It has been possible to obtain single-sweep records of the voltage across the contacts immediately after break with the E.R.A. ultra-high-speed oscillograph and so to confirm the existence of the short arcs. Two of the records are shown in Figs. 1 and 2. It is seen that low-voltage arcs of very short duration exist even when the circuit inductance is as small as 0.09 microhenry. An attempt is being made to relate them to the measurements on the transfer.

Acknowledgments are due to the Director of the Electrical Research Association for permission to publish this communication.

JANET RIDDLESTONE

Electrical Research Association,
5 Wadsworth Road,
Perivale, Middlesex.
Jan. 13.

¹ Holm, R., "Electric Contacts" (Gebers Förlag, Stockholm, 1946).

Lander, J. J., and Germer, L. H., *J. Appl. Phys.*, **19**, 910 (1948).

² Lander, J. J., *J. Appl. Phys.*, **19**, 1128 (1948).

³ Germer, L. H., and Haworth, F. E., *J. Appl. Phys.*, **20**, 1085 (1949).

⁴ Germer, L. H., and Smith, J. L., *J. Appl. Phys.*, **23**, 553 (1952).

⁵ Warham, J., *J. Inst. Elect. Eng.*, **100**, Part 1, 163 (1953); *Inst. Elect. Eng. Mono. No. 103* (July 1954).

The New British Museum Law

THE new British Museum Bill which passed its third reading in the House of Lords on April 27 has become law. It is of profound importance to all research scientists in biology and geology; but it had a meteoric flight through the House of Commons and the House of Lords. Its transit was apparently unheralded in the Press: its purport is of such national importance that it is surprising that no reference to the course it took through the Houses of Commons and Lords was available to biologists all over the world.

The Bill's second reading (*Hansard*, April 4, 1955, cols. 943-59) was proposed by the Financial Secretary to the Treasury (Henry Brooke), saying, "Its main purpose is to render it possible for objects in the Collection of the Natural History Museum to be lent abroad for research purposes". He was strongly supported by a Trustee, Mr. Chuter Ede, who spoke of the need to reciprocate in the loan of insects, etc., with foreign museums which lend to us. He was followed by five speakers, all congratulatory about the Bill, but not one of them made any reference whatever to type specimens, or showed that they knew of the danger to types in the Bill they were so complacently voting for.

The Bill was exceedingly short (one page) and its main purport was to allow the loan of specimens, which always hitherto has been prohibited.

On reading *Hansard*, I was alarmed by the threat to type specimens in this Bill. I ascertained that important officials of the Natural History Museum were also alarmed. Communications with Mr. Chuter Ede effected nothing. The Bill was passed with no alteration on April 6 (*Hansard*, col. 1,305) when Mr. Ede expressed "very sincere thanks for the expedition with which the Bill has been considered".

The *Manchester Guardian* published a letter from me on April 19. In it I wrote: "I am horrified by the way the bill has been so rushed . . . All it needs, however, is the addition of one short clause making it clear that type specimens are reserved and are never to be lent", and I made an appeal to the Lords to save the situation.

In the House of Lords the Bill was introduced by the Lord Chancellor, read a second time, and it was then anticipated that it would go through automatically. Fortunately, Lord Chorley, alive to the danger to type specimens, proposed an amendment that they should be reserved and never lent from the British Museum. This postponed consideration for a week. Meanwhile, Sir Guy Marshall, an entomologist, wrote to the *Manchester Guardian* (April 23) favouring the idea that type specimens of insects should be loanable. The *Manchester Guardian* published my reply (April 27), in the course of which I wrote: "The Lord Chancellor, proposing the bill, referred to my letter in your issue of April 19 and gave a solemn assurance that type specimens would be carefully protected by museum regulations. But surely it is bad law-making to pass a law that at once requires regulations to counter its purport. The British Museum should be adamant in retaining its proud position as being the only place in the world where every expert can be sure of finding types on the premises were he to arrive suddenly by air with only a few hours to do the comparative work he required. Under the projected bill he might arrive counting on this and find the essential type thousands of miles away. This is deplorable".

The same day the Bill was in the House of Lords Committee stage to consider Lord Chorley's amendment, Lord Chorley moved after "Provided that", to insert: "(a) the said power shall not extend to the lending of type specimens; and (b)" (*Hansard* for the Lords, April 27, cols. 599-603). Lord Chorley said, "your Lordships will appreciate that the type specimen, which is the very fountain of the work of research in its line, is of great importance. . . . It is true that the noble and learned Viscount went some distance in his speech on Second Reading to meet this point when he promised that the Trustees would make regulations under which type specimens would only occasionally be lent out, and I and those for whom I speak are grateful for his promise in that regard. But I suggest that it is not altogether satisfactory to be content with promises of that kind".

The Lord Chancellor (Viscount Kilmuir) said he hoped the amendment would not be pressed; but he promised that, "the Trustees of the British Museum, of whom I have the honour to be one, will regard this matter most scrupulously and will use this power in respect of type specimens only in the most unusual cases".

He was followed by the Earl of Ilchester, "the Trustees, of whom I am one, feel strongly on this point. . . . I wonder whether they will ever go out . . . every care will be taken to ensure that no specimen that should not go out is allowed to go".

Lord Strabolgi, supporting Lord Chorley, asked for a time-limit for loans.

He was at once answered by the Lord Chancellor, who said, "I will look into this point with pleasure".

Lord Chorley then withdrew his amendment, and said, "So long as these points are within the vivid recollection of the Trustees, I am sure they will see to it that they are properly attended to".

In the course of the hurried passage of the Bill the efforts to deal with such an important matter could not be mobilized. The keepers in the Natural History Museum, who are the chief experts, each responsible for the specimens dealing with his own science, whose opinions in this matter are of prime importance, were unrepresented. I asked at least one of the keepers to come to the House of Lords before the hearing so that one or two of the Lords might be informed by expert opinion, but as British Museum officials are Civil servants it was out of the question that any of the real experts could take any part in the 'back-stage' discussion which could only be conducted with the Director of the Natural History Museum, who was out of the country.

However, the consideration shown by the House of Lords and the promises made in response to Lord Chorley's efforts are reassuring, although the types are no longer protected by law as heretofore.

But it is evident scientists should always be on the alert, and it is to be hoped that in future more time will be given to any legislation affecting scientific matters of importance.

The quotations I have made are brief, and everyone interested in the Natural History Museum should read the verbatim reports in *Hansard*: Commons, April 4 and 6; Lords, April 21 and 27.

MARIE C. STOPES

Norbury Park,
Dorking,
Surrey.
May 3.

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, May 23

* **BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP** (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. S. F. Nadel: "Magic Thinking".

Tuesday, May 24

SOCIETY FOR ENDOCRINOLOGY (at the Royal Society of Medicine, Wimpole Street, London, W.1), at 5 p.m.—Dr. A. Lacassagne (Paris): "Endocrine Factors Concerned in the Genesis of Experimental Mammary Carcinoma".*

* **WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY** (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. Lord Stamp: "The Action of Bacterial Enzymes on Immunizing Antigens" (Almroth Wright Lecture).

INSTITUTION OF CHEMICAL ENGINEERS (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Prof. Warren K. Lewis: "Mechanism of Fluidization of Powders in Gases".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Sir John Cockcroft, F.R.S.: "Nuclear Power and World Energy Resources" (James Forrest Lecture).

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. R. M. Barrer: "Some Tasks and Perspectives in Physical Chemistry"* (Inaugural Lecture).

Tuesday, May 24—Friday, May 27

INSTITUTION OF GAS ENGINEERS (at Portsmouth and Southsea)—92nd Annual General Meeting.

Wednesday, May 25

POLAROGRAPHIC SOCIETY (in the Chemistry Department, The University, Leeds), at 10 a.m.—Symposium on "Polarographic Instrumentation—Design and Application".

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. Alan A. Burrows: "Use and Abuse of Sound".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. H. Read, F.R.S., and Prof. O. O. Farquhar: "The Buchan Anticline of the Banff Nappe of Dalradian Rocks in North-East Scotland"; Dr. J. Sutton and Dr. J. Watson: "The Boyndie Syncline of the Dalradian of the Banffshire Coast".

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Annual General Meeting, followed by Symposium on "Factors Influencing Host-parasitic Relationships". Speakers: Dr. E. L. Taylor, Prof. A. A. Miles and Mr. F. C. Bawden.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. J. O. Irwin: "A Unified Derivation of Some Frequency Distributions of Importance in Biometry and Statistics".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. A. H. Waterhouse: "Twins and Genetics".*

Thursday, May 26

INSTITUTION OF MINING AND METALLURGY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting 5.15 p.m.—Mr. Stanley Robson—Presidential Address.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER (university graduate with appropriate teaching and industrial experience) in **PHYSICS**—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex (May 26).

LECTURER IN MATHEMATICAL STATISTICS, a **LECTURER IN BIOCHEMISTRY**, a **LECTURER OR ASSISTANT LECTURER IN PSYCHOLOGY**, an **ASSISTANT LECTURER IN PURE MATHEMATICS**, an **ASSISTANT LECTURER OR RESEARCH ASSISTANT IN VIRUS DISEASES** and a **RESEARCH FELLOW IN ASTRONOMY OR ASTROPHYSICS**—The Secretary, University College, Exeter (May 27).

ASSISTANT EXPERIMENTAL OFFICER IN THE GENETICS DEPARTMENT, to be responsible for the maintenance of genetic stocks and to assist the Head of the Department—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (May 28).

EXTENSION LECTURER (with academic qualifications in pure science, preferably in physics or chemistry) in **SCIENCE** in the Department of Extra-Mural Studies—The Director of Extra-Mural Studies, (King's College), Joseph Cowan House, 153 Barras Bridge, Newcastle-upon-Tyne (May 28).

LECTURER IN MATHEMATICAL PHYSICS—The Registrar, The University, Edgbaston, Birmingham 15 (May 28).

LECTURER (with an honours degree in electrical engineering or equivalent, and practical experience in either the heavy power side of electrical engineering or the light current side) in the **DEPARTMENT OF ELECTRICAL ENGINEERING**—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (May 28).

SENIOR LECTURER (with special qualifications in organic chemistry) in the **DEPARTMENT OF CHEMISTRY**—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (May 28).

VIROLOGIST, Scientific Officer grade (with a first- or second-class honours degree in botany) in the **DEPARTMENT OF AGRICULTURE FOR SCOTLAND**, Plant Pathology Station, East Craigs, Corstorphine, Edinburgh, to assist in field, laboratory and glasshouse research and routine work concerning potato diseases generally, and with particular stress on virus diseases and those affecting the quality of potato tubers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.89/5A (May 30).

LECTURER IN PHYSICS—The Secretary of University Court, The University, Glasgow (May 31).

LECTURER IN PHYSIOLOGY, and an **ASSISTANT IN PHYSIOLOGY**—The Secretary of University Court, The University, Glasgow (May 31).

LECTURER OR SENIOR LECTURER IN CHEMISTRY at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 31).

LIBRARIAN (preferably male, with a degree in natural or agricultural science), and a **JUNIOR LIBRARY ASSISTANT** (female)—The Secretary, Grassland Research Institute, Hurley, near Maidenhead (May 31).

SCIENTIFIC OFFICER (with a good honours degree in biological sciences and postgraduate experience in cytology) to undertake research on problems related to plant breeding—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (May 31).

ASSISTANT LECTURER (with special qualifications in plant physiology) in **BOTANY**, and an **ASSISTANT LECTURER IN ANIMAL GENETICS**—The Secretary and Registrar, University College of North Wales, Bangor (June 1).

LECTURER (with a good honours degree) in **BOTANY OR ZOOLOGY**, at the **Nigerian College of Arts, Science and Technology**—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (June 1).

RESEARCH FELLOW in the **DEPARTMENT OF MATHEMATICAL PHYSICS**—The Registrar, The University, Birmingham 15 (June 4).

ASSISTANT LECTURER IN PSYCHOLOGY—The Registrar, The University, Sheffield (June 7).

UNIVERSITY DEMONSTRATOR (with an honours degree in pure science with organic chemistry and biochemistry, as the principal subjects, and preferably with farming experience) in **ANIMAL NUTRITION**—The Secretary, School of Agriculture, The University, Cambridge (June 8).

LECTURERS IN BACTERIOLOGY, BIOCHEMISTRY, ANIMAL HUSBANDRY AND CROP PRODUCTION at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 10).

PHYSICAL CHEMIST, Senior Research Officer or Research Officer grade (with a university honours or higher degree in science with physical chemistry as the major subject or equivalent qualifications, and preferably with research experience in surface chemistry), in the **DIVISION OF PLANT INDUSTRY**, Commonwealth Scientific and Industrial Research Organization, Canberra, A.C.T., Australia, to work on physicochemical problems arising from the investigation of the Division, initially on the action of herbicides at cell surfaces and intersurfaces, and on their movement within plants—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 130/202 (June 11).

PLANT PATHOLOGIST, Research Officer or Senior Research Officer grade (with an honours or higher degree in science, agricultural science or equivalent qualifications, and with research experience in plant pathology or mycology) in the **DIVISION OF PLANT INDUSTRY**, Commonwealth Scientific and Industrial Research Organization, Canberra, A.C.T., to undertake plant disease investigations and in particular to study fundamental aspects of host-pathogen relationships and mechanisms of resistance to disease—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 130/241 (June 11).

SENIOR LECTURER IN PHYSICS—The Registrar, The University, Sheffield (June 11).

LECTURER OR ASSISTANT LECTURER IN BIOCHEMISTRY—The Registrar, The University, Leeds 2 (June 13).

ROBERT RANKIN CHAIR OF ELECTRONIC ENGINEERING—The Registrar, The University, Liverpool (June 18).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (June 15).

CHAIR OF PHILOSOPHY at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 15).

SOIL CONSERVATORS (3) (preferably with experience in soil conservation practices) with the Otago Catchment Board, New Zealand—The Agricultural Liaison Officer, New Zealand House, 415 Strand, London, W.C.2 (New Zealand, June 15).

LECTURER IN GEOLOGY, with special reference to Palaeontology—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (June 18).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Leeds (June 20).

DEMONSTRATOR (preferably with an interest in soil science) in **GEOLOGY**—The Registrar, Wye College, near Ashford, Kent (June 25).

GEOMORPHOLOGIST, Research Officer grade (with a university honours degree with a strong geological background, and preferably with special training and subsequent experience in geomorphology), in the **LAND RESEARCH AND REGIONAL SURVEY SECTION** of the Commonwealth Scientific and Industrial Research Organization, Canberra, to be a member of a scientific unit conducting potentiality surveys of undeveloped regions—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 570/88 (June 25).

SENIOR RESEARCH FELLOW IN PHYSICS, at the University of New England, Armidale, New South Wales, Australia, to undertake a programme of experimental or theoretical research, preferably, but not necessarily, in the field of ionization and discharge physics or of solid state physics—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 27).

DEMONSTRATOR or LECTURER IN THE DEPARTMENT OF ZOOLOGY—The Dean, Medical College of St Bartholomew's Hospital, West Smithfield, London, E.C.1 (June 30).

PLANT BREEDER (Fruit), Senior Scientific Officer or Scientific Officer grade, at the Research Station, Long Ashton, Bristol—The Registrar and Secretary, The University, Bristol 8 (June 30).

PROFESSOR OF GEOLOGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 30).

SENIOR LECTURER (with a good honours degree and research experience, preferably in plant pathology, systematic botany or genetics) in **BOTANY**, at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (June 30).

TECHNICAL OFFICER (with an honours degree in electrical engineering, physics or chemistry, and experience in the design and construction of electronic apparatus for the study of chemical problems, with special reference to flash discharges and micro-wave spectroscopy) in the **DEPARTMENT OF PHYSICAL CHEMISTRY**—Dr F. B. Kipping, University Chemical Laboratory, Pembroke Street, Cambridge (July 1).

ASSISTANT LECTURER, Grade B (preferably with some teaching, industrial and/or research experience) in the **DEPARTMENT OF PHYSICS**—The Principal, Royal Technical College, Salford 5.

ASSISTANT LECTURER (graduate in chemistry or biochemistry and preferably with experience in the food industry)—The Principal, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

CHAIR OF PHYSIOLOGY at Makerere College (The University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1.

CHEMIST, Scientific Officer or Senior Scientific Officer grade (with an honours degree), to work in a team investigating fundamental aspects of the structure of certain dielectric materials—The Director of Research, British Ceramic Research Association, Queens Road, Penkhill, Stoke-on-Trent.

DEPARTMENTAL DEMONSTRATOR (with a good degree in any branch of engineering and preferably with postgraduate experience) in **ENGINEERING SCIENCE**, for duties which include both lecturing and undergraduate instruction in the laboratories—Professor of Engineering Science, 19 Parks Road, Oxford.

EXPERIMENTAL OFFICER (with at least H.S.C. in science subjects or equivalent qualifications and preferably with some experience in physics, electronics or spectrochemistry or any combination of these) in the **SPECTROSCOPY GROUP**, for work which includes spectrochemical analysis with emphasis on the development of new techniques (for example, electronic direct recording) and spectro-physical examination of the transuranic element spectra—The Establishments Officer, United Kingdom Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting 2/103/295.

GOVERNMENT CHEMIST (with a degree in chemistry of a British university) in the **MEDICAL DEPARTMENT** of the Gold Coast Local Civil Service, for the analysis of foods, drugs, wines and spirits, textiles, and pathological samples, including poisons—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.117/13/012.

INTERNATIONAL WOOL SECRETARIAT RESEARCH FELLOW (with chemical or biochemical qualifications) to undertake work on the physical chemistry of the wool fibre—The Principal, Technical College, Bradford.

LECTURER IN EDUCATION at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1.

LECTURER IN ZOOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council of Higher Education Overseas, 1 Gordon Square, London, W.C.1.

RESEARCH ASSISTANT (Ph D standard), for work on reaction kinetics at gas-solid interfaces—Dr. F. C. Tomkins, F.R.S., Imperial College, London, S.W.7.

RESEARCH ASSISTANTS (2) IN PHYSICAL CHEMISTRY—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

STATISTICIAN (preferably with experience of field trials)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

The Reconciling Spirit and the Economic Order. By Prof. Charles F. Carter. (Alex Wood Memorial Lecture, 1955, delivered in Trinity College, Glasgow, February 19th 1955.) Pp. i+17. (London: Fellowship of Reconciliation, 1955.) 1s. 6d. [153]

In Search of Economic Sanity: the Christian's Task in the Clash of Ideas. By Elnora Ferguson. Pp. 6. (London: Fellowship of Reconciliation, 1955.) 2d. [153]

Copper Development Association. Publication 50: The Strength of Copper Tubes and Cylinders: Design Data. Pp. iv+44. (Radlett: Copper Development Association, 1955.) [153]

United Nations Technical Assistance: Report on visits to the Technical Assistance Administration of the United Nations in New York, in September 1954, and to the Food and Agriculture Organisation in Rome, in October 1954. Pp. 38. (London: Federation of British Industries, 1955.) 2s. 9d. [153]

Association of Universities of the British Commonwealth. Report of the Proceedings of the 1954 Conference of the Universities of Great Britain and Northern Ireland, convened by the Committees of Vice-Chancellors and Principals, and held in the William Beveridge Hall, University of London, Senate House, on Friday and Saturday, December 17th and 18th, 1954. Pp. 110. (London: Association of Universities of the British Commonwealth, 1955.) 2s. 6d. [153]

Department of Scientific and Industrial Research. Scientific Research in Russia: a Brief Survey of Recent Work from a Russian Source. (Translated from *Priroda* 1954 (3) 3-10. Reprinted from the Translated Contents Lists No. 71, February 1955.) Pp. xvii. (London: Department of Scientific and Industrial Research, 1955.) [153]

Other Countries

State of California: Department of Fish and Game. Fish Bulletin No. 98: The Life Histories of the Steelhead Rainbow Trout (*Salmo gairdneri gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*), with Special Reference to Waddell Creek, California, and Recommendations Regarding Their Management. By Leo Shapovalov and Alan C. Taft. Pp. 375. (Sacramento, Calif.: Printing Division, Documents Section, Department of Fish and Game, 1954.) [153]

South African Council for Scientific and Industrial Research. National Building Research Institute. Housing for the Urban Bantu—a Problem in Whole Engineering. By J. E. Jennings. (Pretoria: South African Council for Scientific and Industrial Research, 1954.) [153]

Smithsonian Miscellaneous Collections. Vol. 123, No. 7: Early Cenozoic Vertebrates in the Red Conglomerate at Guanajuato, Mexico. By Carl Fries, Jr., Claude W. Hibbard and David H. Dunkle. (Publication 4181.) Pp. ii+25+1 plate. (Washington, D.C.: Smithsonian Institution, 1955.) [153]

Yale Medical Library. Annual Report including Report of the Historical Library, 30 June 1954. Pp. 32. (New Haven, Conn.: Yale Medical Library, 1954.) [153]

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 112, No. 2: Deep Water Elasmobranchs and Chimaeroids from the Northwestern Atlantic Slope. By Henry B. Bigelow and William C. Schroeder. Pp. i+37-88. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [153]

Metropolitan Life Insurance Company. Statistical Bulletin. Vol. 36, No. 1 (January 1955): All-Time Low Mortality in 1954. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [153]

Report and Accounts of the National Botanic Gardens of South Africa, for the year ended 31 December 1954 (Kirstenbosch, Newlands, Cape; and the Karoo Garden, Worcester). Pp. 22. (Kirstenbosch, Newlands, and Karoo Garden, Worcester: National Botanic Gardens, 1955.) [153]

City of Durban. Durban Museum and Art Gallery. Annual Report for the Municipal Year 1953-1954. Pp. 15. (Durban: Durban Museum and Art Gallery, 1955.) [153]

Durban Museum Novitates. Vol. 4, Part 10th. New and Interesting Cerambycidae (Coleoptera) chiefly from Southern Africa. By E. F. Gilmour. Pp. 119-150. Vol. 4, Part 11: New Genera, Species and Varieties of Lamelinae (Coleoptera, Cerambycidae) from South Africa. By the Rev. J. Wesley Hunt and Dr. Stephan Brennum. Pp. 151-160. (Durban: Durban Museum and Art Gallery, 1954 and 1955.) [153]

International Nickel Company of Canada, Limited. Annual Report for 1954. Pp. 28. (Copper Cliff, Ontario: International Nickel Company of Canada, Limited, 1955.) [153]

Uganda Electricity Board. Seventh Annual Report and Accounts for the year ended 31st December, 1954. Pp. 33+12 plates and 2 maps. (Kampala: Uganda Electricity Board, 1955.) 1s. [153]

Companhia de Diamantes de Angola (Diamang). Dundo—Lunda—Angola. Serviço de Saude. Subsídios Para o Estudo da Antropologia na Lunda. Contribuição para a Estudo da Antropometria dos Indígenas da Lunda e Songo. Por J. H. Santos David. Pp. 244 (24 plates). (Lisboa: Companhia de Diamantes de Angola, 1955.) [153]

Annual Report of the Indian Council of Agricultural Research for 1952-53. Pp. ix+189. (Delhi: Manager of Publications, 1954.) 3 rupees, 6 annas; 5s. 6d. [153]

Indian Forest Bulletin No. 183 (New Series). Cellulose and Paper. Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board. Part 21: Soda Pulp for Writing and Printing Papers from *Themeda cymbaria* Hack (Elephant Grass). By R. V. Bhat and S. C. Asthana. Pp. ii+6. (Delhi: Manager of Publications, 1954.) 7 annas; 8d. [153]

Annals of the New York Academy of Sciences. Vol. 59, Art. 3: The Relation of Immunology to Tissue Homotransplantation. By James Marquis Converse and 34 other authors. Pp. 277-466. 4 dollars. Vol. 59, Art. 4: Ionizing Radiation and the Cell. By Leslie F. Nims and 22 other authors. Pp. 467-664. 4 dollars. (New York: New York Academy of Sciences, 1955.) [153]

E. I. du Pont de Nemours and Company. Annual Report for the year 1954. Pp. 50. (Wilmington, Delaware: E. I. du Pont de Nemours and Company, 1955.) [153]

Commonwealth Scientific and Industrial Research Organization, Australia. Division of Fisheries Technical Paper No. 3: The Occurrence of Oily Pilchards in New South Wales Waters. By M. Blackburn and R. Downie. Pp. 11. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1955.) [153]

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

- **Building Research Station Digest**. No. 74 (February 1955): Corrosion Resistant Floors—Part 2: Materials for Finishes. Pp. 4. (London: H.M. Stationery Office, 1955.) 3d. net. [93]

Aero Research Technical Notes. Bulletin No. 145: "Trofdek"—a Further Use for "Aerolite" 300 in Building Structures. Pp. 4. (Duxford: Aero Research Limited, 1955.) [93]

West African Cacao Research Institute. Technical Bulletin No. 1: A Summary of the Results of Capsid Research in the Gold Coast. By D. J. Taylor. Pp. 20+5 plates. 2s. 6d. Technical Bulletin No. 2: Capsids and Capsid Control in the Belgian Congo, with special reference to Lukolela Plantations. By J. Nicol and D. J. Taylor. Pp. 10+2 plates. 1s. (London: Crown Agents for Oversea Governments and Administrations, 1954.) [93]

Department of Scientific and Industrial Research. Report for the year 1953-54. (Cmd. 9388.) Pp. 326. (London: H.M. Stationery Office, 1955.) 9s. net. [113]

NATURE

No. 4465

SATURDAY, MAY 28, 1955

Vol. 175

CONTENTS

	Pdge
Science and Responsibility	913
Animal Population Problems. By Dr. L. Harrison Matthews, F.R.S.	915
Administrative Medicine. By Prof. T. Ferguson	916
Freedom and Authority. By R. Brightman	916
Diseases of Farm Animals in Britain. By Dr. J. T. Stamp	917
Fifty Years of the Theory of Relativity. By Prof. André Mercier	919
Radio Research Station, Ditton Park, Bucks. By Dr. R. L. Smith-Rose, C.B.E.	921
Bristol Meeting of the British Association	923
Obituary : Prof. Albert Einstein, For.Mem.R.S. By Prof. W. H. McCrea, F.R.S. ; Dr. Robert W. Lawson	925
News and Views	927
The U.S. National Academy of Sciences : Annual Meeting	931
Twelfth General Assembly of the International Union of Biological Sciences	932
New Engineering Building for the University of Sheffield	932
Forestry Research in Great Britain. By Prof. E. P. Stebbing	934
Wool Industries Research Association : Report for 1954-55	935
University College, London : Annual Report for 1953-54	935
Growth of Muscle Fibre in the Foetal Sheep. By D. M. Joubert	936
Tidal Gravity Measurements in the Shetlands : Effect of the Total Eclipse of June 30, 1954. By Prof. R. Tomaschek	937
Letters to the Editors :	
Sleep in Ruminants.—Dr. C. C. Balch	940
Responses of Some Marine Plankton Animals to Changes in Hydrostatic Pressure.—Dr. E. W. Knight-Jones and S. Z. Qasim	941
Astaxanthin in the American Flamingo.—Prof. Denis L. Fox	942
Recognition of Appropriate Backgrounds by the Pale and Black Phases of Lepidoptera.—Dr. H. B. D. Kettlewell	943
Genotype-Environment Interactions in <i>Lolium perenne</i> .—S. O. Fejer	944
Zinc in the Metabolism of <i>Fusarium vasinfectum</i> Atk.—R. Kalyanasundaram and Miss L. Saraswathi-Devi	945
Nicotine Degradation <i>in vitro</i> induced by Agents from Tobacco Seed.—Dr. Walter G. Frankenburg	945
Identity of the Acetylcholine-like Substance in the Housefly.—W. Chefurka and Dr. B. N. Smallman	946
A Reliable Physiological Index for evaluating Summer Clothing.—B. L. Pertl and B. B. Lal	947
Internal Friction of White Tin Single Crystal.—Toranosuke Komata	948
A New Method for measuring Electrical Resistivities.—Dr. K. G. Ramanathan and J. S. Dhillon	948
Focusing of Waves in Radio Reception.—H. V. Griffiths	948
Thunderstorm Signals at Very-high Frequency and Ultra-high Frequency.—Dr. C. R. Hay and T. R. Hartz	949
Infra-red Spectrum of the Night Sky near 10000 Å.—Dr. A. Vallance Jones	950
Identification of Water-Masses by their Suspended Matter.—Dr. W. R. G. Atkins, O.B.E., F.R.S., and Pamela G. Jenkins	951
Antioxidant Activity of Redox Dyes.—V. P. Maier and A. L. Tappel	951
An Optically Active Spirocyclic Phosphonium Salt.—Dr. F. G. Mann, F.R.S., and E. A. Hart	952
Correction of 'Crude-Fibre' Estimation for the Effect of Altitude.—H. W. Dougall	952
A Modified Method of Filter Paper Electrophoresis.—Dr. H. Zentner	953
Isolation of Fungi from Hyphae present in Soil.—Dr. J. H. Warcup	953
<i>Elminius modestus</i> Darwin, a Northward Extension of Range.—Joseph H. Connell	954
A Chiton, <i>Callochiton fulvus</i> (Wood), in the River Fal.—R. H. Baird	954
Recent Scientific and Technical Books	Supp. viii

Editorial and Publishing Offices of Nature

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number : Whitehall 8831. Telegrams : Phusis Lasquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1

Telephone Number : Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

DIFCO

PEPTONES AND HYDROLYSATES for Microbiological Culture Media

Difco peptones and hydrolysates are prepared to meet the diversified nutritional and biochemical requirements of microorganisms. A single peptone cannot provide the essential nitrogenous nutrients for all cultural and metabolic processes. Difco peptones and hydrolysates have been developed to meet the various requirements for microbiological procedures including growth, preparation of toxin and vaccines, and for the study of microbial metabolism.

BACTO-PEPTONE
BACTO-TRYPTOSE
PROTEOSE-PEPTONE

PROTEOSE-PEPTONE NO. 3
NEOPEPTONE
BACTO-TRYPTONE
BACTO-VITAMIN FREE CASAMINO ACIDS

BACTO-CASITONE
BACTO-CASAMINO ACIDS
BACTO-CASAMINO ACIDS
TECHNICAL

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

Sole Agents for Gt. Britain

BAIRD & TATLOCK (LONDON) LTD.
FRESHWATER ROAD · CHADWELL HEATH · ESSEX

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

*World's Largest Stockists
of Scientific Periodicals*

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading
Universities, Public Libraries
and Institutions of the World.
Catalogues issued.

SELLING?

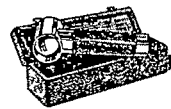
Specialists in Scientific,
Technical Books and
Publications of all
Learned Societies.

Why not consult us first?

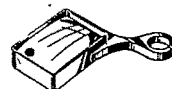
4 DUKE STREET, MANCHESTER SQUARE,
LONDON, W.1



"QUICKSET"
MAGNIFIER



"RESEARCH"
Illuminated Magnifier



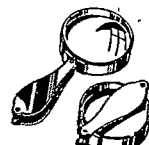
RECTANGULAR
READERS

"ENBEECO" MAGNIFIERS

There is an "Enbeeco" magnifier to meet every conceivable need of industry, science, education and recreation. Patterns include pocket, hand and stand models—folding or non-folding, stand, adjustable stand, illuminating or non-illuminating. Just send us details of your requirements and leave the rest to "Enbeeco"



"EASYSER"
MAGNIFIER



FOLDING
READERS

36 PAGE MAGNIFIER CATALOGUE
Fully illustrated, sent FREE on request

NEWBOLD & BULFORD LTD
ESTABLISHED 1844
Manufacturers and Exporters of Optical and
Scientific Instruments and Ophthalmic Supplies etc.
ENBEECO HOUSE, ROGER ST. GRAYS INN RD. WC1
TELEGRAMS: NEWBOLD LONDON
TELEPHONE: 2411 (5 LINES)

Enbeeco
PRODUCTS
LEACH

SCIENCE AND RESPONSIBILITY

THE Government's decision to undertake the manufacture of thermonuclear weapons, although now generally accepted by the major political parties, has clearly been accepted with reluctance; and even from the point of view of defence there have been misgivings as to whether all the implications have been fully considered, and whether Britain's limited resources are deployed to the best possible advantage. Apart, however, from the questions whether sufficient readjustments have been made elsewhere in our defence programme and whether all that is possible has been achieved in the way of co-operation within the North Atlantic Treaty Organization or with the United States, other doubts have arisen from the limitations of our knowledge of the biological effects of radiations generated in nuclear explosions. These misgivings may well be largely dispelled when the promised report from the Medical Research Council is published; but there will then still remain the moral question whether the use of nuclear, and especially thermonuclear, weapons is ultimately justifiable.

That this aspect is profoundly disturbing even to those who accept the Government's decision as right and as inescapable at present is to be seen, for example, in the leading article, "The Moral Crisis", which appeared in *The Times* of March 14, and which was quoted by the Archbishop of York in the most outstanding speech in the debate on defence in the House of Lords on March 16. Dr. Garbett said that the decision raises moral and ethical questions of the first importance. Lasting peace, he said, will be achieved only by facing the moral issue and accepting the moral responsibility, realistically and unflinchingly. It requires vision and imagination, clarity of thought, and strength.

Dr. Garbett made no secret of his dislike of nuclear weapons. "I would to God they had never been invented", he said. But he recognized also that we cannot put back the clock, that we must face the possibilities of abuse, just as we accept the prospect of using these same scientific developments to provide new sources of industrial power, and that the decision whether or not thermonuclear bombs are used does not rest with Britain alone. It rests with those who would be quite uninfluenced by protests and decisions, and Dr. Garbett said he could not accept the argument that we could secure even our own safety by a unilateral renunciation of such weapons. He does not think that a democratic government can refuse to make such weapons unless it is certain that the great majority of those it represents are deliberately prepared to accept the consequences, with the destruction of our way of life and the obliteration of individual human values, quite apart from the sufferings which would be brought to millions. It cannot be claimed to-day that Britain is overwhelmingly pacifist, and he agreed rather with Lord Swinton that the mere fact that a peace-loving nation like our own possesses these bombs might prevent the bomb from ever

being used for fear of the retaliation which would follow. The chief justification for making the bombs must be that they would provide a shield behind which the work of peace-making can be continued. Almost any road is worth exploring if it will lead to peace; almost any risk is worth taking if it will help to dispose of the suspicion and fear which lead to war.

As part of this desperate and continuous effort to create an atmosphere in which peace will be lasting, Dr. Garbett urged that Britain and others must be made fully aware of the destructiveness of this weapon. There was evidence enough in the defence debates to justify his doubts whether the people living behind the Iron Curtain are allowed to know about the results which would follow the use of the thermonuclear bomb. Nevertheless, he thought it would be possible and worth while for men of science of all nations to draw up a simple statement of the ruin which nuclear warfare would bring to the world. If the Communist powers refused to circulate it, the democracies should use every possible means to enlighten the people of the world as to the consequences of the use by their rulers of nuclear bombs.

What has been made clear above all by the Archbishop of York's speech is that the decision to make the bombs is not enough by itself, even as deterrent. The deterrence lies also in the steadiness and determination of men's minds, and the great merit of such papers as those of Edward Teller, "The Work of Many People" (*Science*, 121, 267; 1955), J. R. Schenken, "The Scientist as a Citizen" (*ibid.*, 121, 184), Gerard Piel's "Need for Public Understanding of Science" (*ibid.*, 121, 317), or Prof. C. F. Powell's address at the "H-Bomb and Gun" Conference in London on February 26, is that they encourage the clear thinking and understanding of all that is involved, which are demanded no less of the scientist himself than of the ordinary citizen. They help to provide the perspective against which sound judgments and right decisions can be made.

It must be remembered, for example, that the great advances in nuclear physics which have placed these vast powers for good or evil in our hands are, not accidental. They are the outcome of an approach, relatively new in human history, to the problem of winning knowledge and control from Nature; and while their implications for human life, as Prof. Powell observes, far surpass anything which has gone before, the discoveries themselves follow from the discoveries of the past. We have entered an epoch marked by ceaseless technical innovation, with all the perplexities and opportunities which are thus created, and any attempt to anticipate the course of events, in very general terms, must allow for the possibility of new discoveries and innovations.

Prof. Powell's main emphasis is on the instability of the present position and the heavy responsibility resting on those who have some small understanding of the great issues that are in suspense. In a position so precarious, small forces can turn the balance, and our prospects will be brighter the more people are

convinced, and the more firmly and untiringly they insist, that international agreement on nuclear energy can be achieved, that it is essential for our survival, and that it must be achieved in a form which respects the freedom of all peoples to determine their own destinies. That position is essentially the one adopted by Dr. Garbett. Prof. Powell's address is of even greater interest as a complement to the picture which Edward Teller gives of the development of the thermonuclear bomb and the way it involved the contributions of a considerable number of people, ranging from political decisions, to organization and to scientific work.

Teller believes that everyone who has worked on the thermonuclear bomb was appalled by the success and by its possible consequences, but that all connected in any way with the effort were convinced that the work was necessary. He believes that it was necessary to develop the thermonuclear bomb; and that in spite of the danger inherent in its destructive power we should be unfaithful to the tradition of Western civilization if we refused to explore the limits of human achievement. That is the specific duty of the scientist: beyond exploring and explaining, his responsibilities are no greater than those of any other citizen of a democratic society, many of whom have been associated with the scientist in this greater technical achievement.

To be in possession of the thermonuclear weapon is a greater challenge to the free community than its construction was to the technical people. Teller is confident that whatever the scientists are able to discover or invent, the people will be good enough and wise enough to control it for the ultimate benefit of everyone; though he gives no clue as to how and where we are to find and develop the habits of mind, in particular the power to transcend emotional inheritances—which people do not find easy—the virtues of prudence, justice and fortitude, as well as of faith, hope and charity, that will be needed more than ever in national and international policy in the more mobilized life which for the next generation at least we must be prepared to live.

In commenting on the Oppenheimer judgment last autumn, Teller says: "scientists as a group should stay out of politics except in areas touching on science". J. R. Schenken, in his article "The Scientist as a Citizen", shows that failure of the scientist to speak out clearly on the basic concepts of freedom endangers all the virtues which Teller now postulates as essential to enable the free world to meet the challenge of thermonuclear weapons. It is the minority, and not the majority, who challenge truth and create new concepts; and freedom exists only as long as the majority recognizes that the minority must be free to pursue thought wherever it may lead.

Schenken is concerned particularly with the position of medicine, and the prospect that it would remain outside the domain of security regulations, political restraints and the like. He rightly insists on the necessity of broadening the educational basis of medicine, so as to prevent the physician from becoming so engrossed in his own special field that,

forgetting to look after the common good, he loses his right to continue unhampered even his scientific activities; but he overlooks the point made by Dr. Garbett, that those activities are already conditioned by the social milieu in which he works. We cannot disregard the fact that the utterances and activities of scientists behind the Iron Curtain are conditioned rather by the decrees of the State than by their professional discipline.

That fact cannot be ignored in considering the moral responsibility of the scientist as a citizen, and in weighing proposals for broadening professional education and bringing the scientist into closer touch with his fellow citizens. It must be remembered, too, in considering means of furthering public understanding of science. Unless the limitations of science and the scientist are clearly understood, there is danger that the scientist may be expected to exercise powers which he does not possess and which inhere in the community as a whole; or that, blaming the scientist for consequences for which he has no responsibility as a scientist, the community may refuse to support work which is essential for its own safety and welfare. The major movements in arts and letters to-day, remarks Gerard Piel, are anti-scientific in spirit.

National security and the relation between science and government have not been damaged in Britain to the extent which they have in the United States by the obsession with secrecy and the ignorance of science from which it springs, to which Piel refers. He quotes a recent statement of Dr. Vannevar Bush that the mutual respect between the scientific community and the military services achieved during the Second World War has been "almost destroyed and one of the principal reasons is the security system". We are concerned here, however, with the relations between the scientific community and the nation as a whole. Unless those relations are based on a clear conception of the nature of the scientific enterprise and the way the scientist works, the leaders of the community are unlikely to take the right decisions regarding the development and use of thermonuclear weapons, or indeed of nuclear energy in general, or the community to understand and support the essential decisions.

This is not to be interpreted as disregarding the moral qualities emphasized by Teller; on the contrary, it means dispelling the false, purely materialistic view of science. The taxpayer must be shown that science is not solely or simply a branch of technology, and that mere utility does not provide sufficient motive to inspire the curiosity, the initiative, the imagination, and the persistence that are embodied in all great work. As Warren Weaver expressed it in a passage quoted by Piel: "The most imaginative and powerful movements in the history of science have arisen not from plan, not from compulsion, but from the spontaneous enthusiasm and curiosity of competent individuals who had the freedom to think about the things they considered interesting".

There can, indeed, be no retreat from reason without disaster. The human mind cannot deny for long the inescapable conclusions of its capacity to know

and think; and science does broaden and secure the ground upon which men can choose their way of life. If it were clearly understood by the peoples on both sides of the Iron Curtain that the use of thermonuclear weapons in war might put an end to the human race, there might well be no risk of war; but as Lord Russell has said emphatically, it is not enough for one side only to understand the peril of war to-day.

Whatever practical measures can be found to ensure that that peril is clearly understood by both sides, it is important that the limited responsibilities of the scientists as such should be clearly understood. A declaration by eminent scientists that they may no longer be able to help any State to realize its policies seems rather to impute political knowledge and responsibilities which scientists do not possess. Accordingly, it may well be less calculated to serve the establishment of peaceful existence than the report suggested by Dr. Garbett, or Lord Russell's second proposal that a neutral power should draw up a report by experts on the probable consequences of war, designed to elicit the simultaneous admission by both sides to the neutral power that war could not serve their purposes.

These are issues about which the scientist, as such, and as a citizen, should be thinking intensively and constructively. On him rests a large measure of responsibility for creating a clear public understanding, for removing misapprehensions and for making sure that public policy is effectively criticized if at any point it falls short of technical or scientific requirements in respect of safety or welfare. If that responsibility is not accepted by him, it can be undertaken by no one. While the scientist has neither competence nor responsibility as such for the framing of policy, it is his peculiar responsibility as a citizen, both individually and collectively through his professional associations, to see that the technical and scientific issues involved are clearly understood by those concerned, and that both government and governed are in no doubt as to the implications of particular decisions, such as that to undertake the manufacture of thermonuclear weapons.

ANIMAL POPULATION PROBLEMS

The Natural Regulation of Animal Numbers

By Dr. David Lack. Pp. viii + 343. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 35s. net.

THE fluctuation of the sizes of natural populations is extremely restricted compared with what is theoretically possible. In this book, Dr. David Lack sets out to formulate and clarify the problems presented by this fact. About three-quarters of the book is concerned with birds, since the factors regulating natural populations of birds have been particularly studied. In addition, he discusses the problem as it is found in the mammals, fish and insects.

Birds and other animals can increase in numbers with great rapidity, but are usually held drastically in check. The comparative stability of animal

populations, nearly all of which fluctuate between restricted limits, is due to density-dependent controlling factors. Natural selection has moulded the evolution of the reproduction-rate of each species so that the greatest number of young survives to independence. Among mammals and birds, at least, the larger the family above a certain size the fewer the young that survive, for the death-rate is higher when there are more young to share a limited food supply. In birds the number of eggs laid is not the maximum that the adult is physiologically capable of producing; it is limited to the normal clutch-size, which has been determined by the evolutionary processes of each species as the most advantageous. But a rise in population-density has little if any effect on the clutch-size of each breeding pair, although in some mammals starvation does reduce fecundity; in most animals density-dependent variations affect the death-rate much more than the reproduction-rate.

In passerine birds 45 to nearly 70 per cent of the eggs laid produce flying young; in nudifugous species only about 25 per cent. But yearlings have a higher death-rate than adults, and consequently only some 8-18 per cent of the eggs laid produce breeding adults—a much higher proportion than in fish and invertebrates. The annual death-rate ranges from 30 to 60 per cent in most birds, but is as low as 10 per cent in one species of penguin, and these proportions are constant with respect to age. But wild birds—and almost all other wild animals—live only a fraction of their potential life-span, so that when the reproduction-rate is high so too is the adult death-rate, since in a stable population the death-rate balances the birth-rate; the suggestion that the reproduction rate of each species is adapted to its mortality is a fallacy.

Food shortage, predation and disease are the three factors most likely to cause a high mortality when the population density is high, because they can act more severely when numbers are large. The most important of these appears to be food shortage for the majority of species, though the others may have a larger effect in a minority; but it is seldom that either acts alone, and they commonly interact in a complex way. "Probably they interact in every species, though in some species one of them outweighs the others in importance. Their influence may also be modified by factors which, in themselves, act independently of density, and by irregular variations in climate. Finally, the numbers present or breeding in a particular area may be much modified by movements, which are usually adapted to the food supply." The author concludes that reproduction rates are a product of natural selection and are as efficient as possible. "They may vary somewhat with population-density, but the main density-dependent control of numbers probably comes through variations in the death rate. The critical mortality factors are food shortage, predation and disease, one of which may be paramount, though they often act together."

It is interesting that this synthesis of the results of the latest researches on the populations of animals takes us right back to Malthus, who concluded that "the ultimate check to population appears to be want of food . . . but the immediate checks . . . are all resolvable into moral restraint, vice and misery".

The populations of some species of animal undergo regular cycles of increase and decrease in numbers;

there is a four-year cycle, centred on the lemming, in the numbers of mammals and birds on the arctic tundra; a four-year cycle, centred on the vole, in the adjacent open forest; and a ten-year cycle, centred on the Varying hare, in the forests of North America. The graphs representing the size of the population of these species regularly rise to a peak followed by a deep trough. There seems to be no reason for believing that man is subject to biological laws different from those affecting the other animals; the human population of the world has been rising for many years—it has not yet reached its peak, but inevitably it will. The slope of the curve becomes ever steeper, not owing to man's fecundity, which has always been great, but owing to his control of the environment by his great engineering works to improve agriculture, and by his deliberate activities to improve production and reduce mortality through such organizations as the Food and Agriculture Organization and the World Health Organization. The crash is bound to come, and the human population, just like animal populations, is rapidly producing the means of its own destruction—it is possible and, according to some opinion, even probable that he has already contaminated his environment with artificial radioactive substances sufficiently to endanger his survival. There is only one means of escape, if indeed it is not already too late, and that is by devising ways of preventing the birth of unwanted numbers, rather than slaughtering them by mass destruction after they have been brought into the world. The surface of the earth is finite, and the amount of food that it can produce is limited; but long before the limit is reached the human population problem will have been solved—one way or the other.

Dr. Lack's interesting and stimulating book gives these matters only a brief mention in his last paragraph, but the whole of the preceding pages leading up to it makes it quite plain that in spite of religious, political and other prejudices and inhibitions, man is going the same way that all animal populations go when the birth- and death-rates do not balance: if he does not wish to increase the latter, he must control and decrease the former.

L. HARRISON MATTHEWS

ADMINISTRATIVE MEDICINE

Administrative Medicine

Transactions of the Second Conference, December 8, 9 and 10, 1953. Edited by George S. Stevenson. Pp. 164. (New York: Josiah Macy, Jr., Foundation, 1954.) 3 dollars.

BELIEVING that there is "a considerable obstruction to communication and mutual understanding across the disciplines and specialties" and that this is one of the major factors delaying scientific advancement, the Josiah Macy, Jr., Foundation arranges a series of annual conferences in which participates a small group of investigators representing, so far as possible, all the branches of science related to a chosen programme. The aim is to keep the meetings as informal as possible and to encourage the exchange of methods, research plans, concepts and difficulties; the informal nature and tempo of the discussion are preserved in the published transactions. The second programme on administrative medicine included

a study of major components of administrative medicine, home-care programmes and the health services of the Department of Health for Scotland. This conference was attended by twenty-four persons, authorities on differing aspects of administrative medicine—university professors, public health service chiefs, hospital directors, directors of nursing services, directors of health insurance plans, directors of security departments of industrial firms, directors of research programmes, etc. Sir Andrew Davidson, then chief medical officer of the Department of Health for Scotland, was one of the guests.

Summarizing the proceedings of the conference, the chairman, Prof. H. R. Leavell, professor of public health practice at Harvard University, said it had emerged that administrative process has several phases: the recognition that a problem exists; definition of the problem and planning to meet it; development of a strategy of control; performance; and analysis or evaluation. Different types of administrators may be required to deal with each of these phases, though occasionally the necessary qualities may be found in a single (exceptional) individual. Team-work is important.

The personal qualifications of the administrator were discussed, and it was decided that he should be a good mixer, have a sense of humour and a sense of proportion, enthusiasm for his job, a special kind of motivation, and the kind of vision which enables him to visualize and project (perhaps less for certain phases of the administrative process than for others). In addition, he must have training to help him to do his job more effectively, a knowledge of the problem with which he is dealing, a capacity for realizing when he should seek advice, the ability to organize technical personnel and equipment and to relate them to the people to be served; and enough judgment to gauge the probability of success.

T. FERGUSON

FREEDOM AND AUTHORITY

Freedom and Control in Modern Society

Edited by Prof. Morroe Berger, Prof. Theodore Abel and Prof. Charles H. Page. (The Van Nostrand Series in Sociology.) Pp. xii+326. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1954.) 45s. net.

THE fourteen essays comprising this book discuss those problems of individual freedom in an age of large-scale organization, of group relations and the relation of the individual to his government, which have engaged the interest and work of Robert M. MacIver. Further, the essays are written by scholars who admired MacIver, or who have been his students or colleagues; two of them, those by David Spitz and by Harry Alpert, respectively, attempt to evaluate Prof. MacIver's contribution to political and to sociological theory, the former including an appreciation of his theory of political obligation and the way in which MacIver's elaboration of this theory suggests that, within a democracy, means can be found of respecting the ultimate value of personality consistent with the maintenance of the social order.

The remaining essays range over such topics as friendship as a social process, the problem of authority, the political process in trade unions, social groups in the modern world, social structure and goals in group

relations, ethnic groups in America, the interplay of politics and economics in America's changing capitalism, and social change in Soviet Russia. In length and quality the contributions are uneven; but some are much below the standard of the rest. What will most impress any reader familiar with Prof. MacIver's own pellucid style, to which Alpert pays a well-deserved tribute, is the extent to which a volume written in MacIver's honour falls short of the high standard of exposition which he set. This is not true of all the essays: that of Prof. George Catlin on the utility, of political science, like those by Spitz and Alpert, is happily free from jargon; but there is sufficient evidence in this book to support the charge of atrocious writing that Alpert brings against much American sociology in his own essay.

For that reason, it is difficult to assess the value of the book as a whole. It is not to be expected that the specialist will gather much that is new from such a volume, and the pleasure he finds in a tribute to an esteemed colleague cannot but be marred when the expression of that tribute falls so far short of the standard associated with MacIver. More serious is that, in a book addressed at least to a considerable extent to the general reader, a lapse from high standards of exposition into jargon which is largely unintelligible except to the specialist is unfortunate if not reprehensible. The sociologist is entitled to have his own special terms: indeed, it is essential that he should take particular care to define his terms, in view of the varying and loose meanings which are given to such words as 'freedom' and 'authority' in common parlance, let alone in political debate. If, however, he is to make a real contribution in clarifying the ideas of men and women, he must be particularly careful to present the results of his thinking in language which ordinary men and women can understand, and which will neither confuse nor repel them. That this is possible several of these essays demonstrate, notably those of Thomas Cook on individual liberty and Kingsley Davis on the demographic foundations of national power, in addition to those authors already mentioned; it is also demonstrated by a British writer, Sir Ernest Barker, with whose thought MacIver's has something in common. But there is much in this book that, for the reason just given, will do little to advance public understanding of the vital problem of freedom and control in modern society or, as is perhaps more familiar to us, of the responsible exercise of power.

R. BRIGHTMAN

DISEASES OF FARM ANIMALS IN BRITAIN

Farm Animals in Health and Disease

By Dr. W. R. Wooldridge. Pp. xvi + 463 + 56 plates. (London: Crosby Lockwood and Son, Ltd., 1954.) 30s. net.

THIS book is not a scientific text-book but a serious attempt to produce a book for farmers which gives a sensible and reasoned approach to the diseases of animals. It is not another book which gives a number of disjointed and confusing technical facts along with a larger number of 'home' remedies; but it tries successfully to put the question of animal disease into a proper perspective. In consequence, it could be read usefully by everyone interested in livestock production.

The book is divided into two parts: the first covers general aspects of animal disease and the second deals with specific troubles. The first part is subdivided into four main chapters: (1) Good health, in which the normal functioning of the body is simply but well described. (2) Ill-health, in which the general signs of ill-health are given and the causes of disease sensibly set out with proper emphasis on factors other than the microbe. (3) The cost of ill-health, which perhaps cannot be estimated as accurately as one could wish or as the chapter might suggest. (4) The control of disease, which is quite rightly the longest chapter in the section. In this chapter various means of control are well described. The success of legislative and police methods is shown by the complete eradication from Great Britain of cattle plague, bovine pleuropneumonia, sheep pox and scab, rabies and glanders, while foot-and-mouth disease and anthrax are adequately controlled. The control of tuberculosis, swine fever and contagious abortion is also discussed. This chapter also clearly sets out the various aspects of preventive medicine and shows how prevention of disease depends upon early and proper diagnosis, specific vaccines and drugs, good nutrition and management, proper breeding and good pasture management.

The second part deals with the specific diseases of cattle, sheep, goats, pigs, horses, poultry and the rabbit. The chapter on cattle begins with a number of statements of fact regarding numbers of bulls licensed, the amount of food consumed and the economics of the milk and meat trades, and this is followed by a short summary of hygiene on the cattle farm. The third part of the chapter deals with the notifiable diseases, and the information given regarding foot-and-mouth disease and tuberculosis, although brief, is adequate for the purpose. In other sections the calfhood diseases are also adequately described and the attempt to present the predisposing factors is as good as present scientific knowledge permits. The information regarding John's disease in cattle could possibly have been more definite regarding the difficulty of control and the inadequacy of the Johnin test for this purpose. The metabolic diseases of cattle such as milk fever, hypomagnesaemia, acetonæmia and bloat are described briefly, perhaps too briefly, as, for example, in the case of hypomagnesaemia, where greater detail regarding the prevention of the disease by giving additional magnesium either as a mineral supplement or as a pasture fertilizer would have been of practical help to the stockman. Mastitis, contagious abortion and infertility are sufficiently described, although certain features could usefully have been emphasized.

The chapter on sheep diseases quite rightly relates husbandry and disease, and many excellent examples of this relationship are given (although several of the statements could be debated). It is considered that, taking into account the briefness of the chapter, the description of the diseases of the sheep is adequate, but is not sufficient for those really interested and practised in sheep husbandry.

Despite these criticisms, the book is well written and will be useful as a guide to the stockowner and agriculturist, especially those chapters in part one. The second half of the book could also be useful provided it is not mistakenly used as a reference book to give the answer to all the questions of animal disease.

The book is well produced and has many good photographs.

J. T. STAMP

Rendiconti Istituto Superiore di Sanità

Vol. 17. English edition. Pp. x+243+46 plates. (Roma: Fondazione Emanuele Paterno; Oxford: Blackwell Scientific Publications, Ltd., 1954.) 5,000 lire; 57s. 6d.

THIS volume consists of twelve individual and largely unrelated contributions from different authors, each with a summary in English, French, German and Italian. Of these contributions, the majority comprise detailed descriptions of the construction and installation of fermentation vessels ranging in size from 10 to 300 litres capacity and adapted for fermentation research either in aerated or submerged culture. The remaining contributions include chapters on the interrelation of protein and polynucleotide synthesis in *Escherichia coli*, *Romanoa*—a new genus of antibacterial soil fungus—and two particularly interesting and topical papers by G. Sermoniti on heterokaryosis in *Penicillium chrysogenum*.

The technological character of many of these papers must obviously limit the appeal of the volume as a whole. On the other hand, the detailed descriptions, maintenance, specifications and scale drawings of the apparatus described must equally ensure that anyone concerned with experimental fermentation plant will find the experience embodied in these papers invaluable. Many commonly encountered difficulties, such as turbulence, aeration and foaming, have been taken into account, but it must still be a matter for some regret that this lavish publication is likely, in respect of its technical sections, to become outdated within a comparatively short time as the special needs of research lead inevitably to modifications of small-scale fermentation apparatus. The scientific chapters form a group of original contributions in orthodox form, and these must secure a permanent place in scientific literature for the volume as a whole.

A. H. COOK

Stability Theory of Differential Equations

By Richard Bellman. (International Series in Pure and Applied Mathematics.) Pp. xiii+166. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 44s.

THIS volume is introductory and elementary and the account is self-contained. It is a good text for the student about to begin research into stability theory. The style is attractive and does not suffer from the over-concentration so common in contemporary mathematical writing. Each chapter carries a number of exercises and there is a good bibliography, although there are not many references to the work published during the past five or six years.

The first chapter is concerned with the properties of linear systems. The necessary results in matrix theory are stated clearly, and the student unacquainted with the matrix calculus can read the account with ease. The main topic is the study of the asymptotic behaviour of the solutions of the equation $\dot{y} = Ay$, where A is a constant matrix. In the second chapter the equation $z' = [A + B(t)]z$ is considered, where the matrix $B(t)$ is, in some sense, small as $t \rightarrow \infty$. Stability, boundedness and asymptotic behaviour are investigated. Chapters 3 and 4 are concerned with non-linear systems. Two powerful methods are presented: (1) successive approximations, (2) approximation of the differential equations by difference equations. The results of

Poincaré and Liapounoff on stability are developed. Chapter 5 is a short one on the polynomial equation $P(t, u, u') = 0$, and in Chapter 6 the well-known equation $u'' + a(t)u = 0$ is studied. The results are "a combination of ingenuity and special techniques". The last chapter concerns the Emden-Fowler equation $u'' \pm t^m u^n = 0$.

L. S. GODDARD

Mémoires sur la Théorie des Systèmes des Équations Différentielles Linéaires

Par J. A. Lappo-Danilevsky. Vols. 1, 2, 3 bound as one Volume. Pp. xiv+253+208+204. (New York: Chelsea Publishing Company, 1953.) 10 dollars.

IN 1931, J. A. Lappo-Danilevsky, a gifted young Russian mathematician, died suddenly, leaving a great quantity of unpublished work. The Academy of Sciences of the U.S.S.R. made a careful study of this, and in 1933 began the publication in French of these three volumes, which incorporate both the published and unpublished work of Lappo-Danilevsky, with corrections and supplements where necessary. Apparently Western mathematicians took little notice of it until about twenty years later.

The subject of the work is the use of matrices for the discussion of a set of linear differential equations. It is true that this method had been previously used by others, including G. Peano, G. D. Birkhoff and H. F. Baker; but none of these seems to have treated the subject so fully and successfully as Lappo-Danilevsky. As a preliminary, he discusses functions of a matrix variable. His first application to differential equations is to a problem of Poincaré, obtaining results fuller than those of Poincaré himself. Other applications to differential and integral equations follow. There is a unity and naturalness about the work which is very attractive, though the extent of the preliminary theorems required makes the book by no means easy reading.

H. T. H. PIAGGIO

Metallurgy of Welding

By Prof. Walter H. Bruckner. (Pitman Metallurgy Series.) Pp. xii+290. (London: Sir Isaac Pitman and Sons, Ltd., 1954.) 30s. net.

THIS book gives a useful and clearly illustrated account, although in rather a dull style, of the principles and practice of the various methods of welding, their metallurgical aspects, and details of the structure and properties of the metal in the weld region. The treatment includes discussion of heat-flow in metals, considerations of residual stress, weldability, specifications and economic factors. In addition, the author deals with brazing, hard-facing, flame-hardening and metal-spraying.

A specific criticism, especially with respect to the chapter on metallic-arc welding, is that the reader cannot always be sure whether the discussion applies generally, or particularly, to steel. Further, there does not seem to be sufficient detailed and critical comparison of the merits of the various welding processes for specific metals, or of problems associated with particular metals. Another chapter, at least, is needed to discuss the welding of the major metals, separately.

It is generally assumed that the reader has a good background of metallurgical knowledge. Thus, engineers without such knowledge would need to consult first a text-book of engineering metallurgy. It must also be realized that this is an American book and refers predominantly to practice, specifications and literature in the United States.

A. R. BAILEY

FIFTY YEARS OF THE THEORY OF RELATIVITY

By PROF. ANDRÉ MERCIER

Department of Theoretical Physics, University of Berne

EINSTEIN'S first paper on relativity dates from 1905 ("Zur Elektrodynamik bewegter Körper", *Ann. der Phys.*, 17, 891; 1905). Its immense importance invites us to renewed reflexion at the time of the jubilee of its publication. Prof. Einstein's death has thrown a shadow over the Jubilee Conference to be held in Berne in July, but will only deepen the earnestness of its work.

The influence and the consequences of Einsteinian relativity can be considered from three of four main aspects: special relativity, cosmology, the theory of knowledge, and the claim for unitary field theories. We shall not follow exactly this classification, nor shall we take up the historical view, which is well known; we shall look for the achievements in the light of contemporary thoughts.

First, we can develop neither experimental nor theoretical modern micro-physics without taking scrupulous account of the requirements of special relativity. This implies in particular reference to Lorentz covariance in every consideration of relative movements, and integration of mass (mc^2) in all energetic processes. Now quantum theory—though already built up on relativistic considerations by Einstein's initial idea of the photon as well as by de Broglie's concept of material waves—has developed for many years in a non-relativistic form which, of course, one hoped might be a mere Newtonian approximation of a correct relativistic quantum theory. On one hand, there is Dirac's theory of spin-particles, with all the extraordinary consequences of antiparticles as holes in the negative energy-states, of polarizability of vacuum, divergent self-energies and so on; and, on the other hand, the formulation by Heisenberg and Pauli of a theory of quantum fields which from the beginning was given a relativistic background. Despite the difficulties mentioned, both have had an illustrious career, and we can say *grosso modo* that the elaboration of a relativistic micro-physics has been a success.

But there are two important aspects where we must recognize the limits of that great attempt. One is, that the quantum theory, even in its most modern form of relativistic quantum fields, is almost certainly not capable of tackling the real problems of nuclear physics and the behaviour of so-called fundamental (elementary) particles. The other is that, though many theoreticians have developed formalisms to get over the difficulties concerning infinite self-energies and the like, these formalisms are artifices; the difficulties remain and are inherent in the theory as a whole. Furthermore, the relativistic treatment of systems of material bodies or particles is more or less Utopian. So one gets the impression that there is some incongruity and some insufficiency in relativistic quantum theory. Maybe this is not independent of the fact that special relativity symmetrizes time and space co-ordinates, whereas the statistical conception which runs through the whole of the quantum theory makes time a typically singular variable. Now this statistical conception is a corollary of complementarity; therefore, we should not be too surprised if at some time it should be discovered that a quantum conception and a relativistic conception require a framework of a

higher learning if they are to co-exist without any inconsistency whatever.

In some ways, the substitution of Einsteinian relativity for Galilean relativity is a simplification, because it leads towards a more unified model of Nature than did the preceding one. At the same time, categories such as time and space, in the Kantian sense of the *a priori*'s, have lost their independence and so we have come, in a sense, nearer to a thorough understanding of Nature. But at the same time, too, one gets the feeling that intuition has lost its connexion with space and time; they are no longer the same "Formen der Anschauung". So we come automatically to a discussion of the epistemological, and consequently the philosophical, aspects of the theory of relativity, or at least a part of it, as we have so far considered only special, and not general, relativity.

The idea seems to have spread among a number of modern scientists that science, as it grows, will more and more reduce the field of, and absorb, philosophy, or at least metaphysics, until eventually it may disappear as a necessary activity of the human mind. I have actually heard that opinion expressed more than once. But the opinion is due to a misunderstanding consisting in the belief that science grasps the 'problems' of metaphysics one after the other and solves them, so that there remains no philosophical basis at all. But that is not what really happens: the process goes the other way. Philosophy does not 'solve problems', whereas science does. Philosophy, in its relation to science, gathers up the problems of science, which are no longer problems since they have found solutions, and seeks to order them in such a way that a structure of knowledge does, in fact, appear. When we speak of problems in philosophy, they have little in common with problems as they are put and solved in physics, for example. In this sense, special relativity has helped philosophy to take a considerable step forward in the 'problem' of time, that is, in the understanding of the genesis, of the independence, of the priority of the concept, in the distinction between several meanings of the concept of time, etc., and particularly in its correct classification among the categories. This last point has opened the first attack against Comte's positivistic classification of the sciences, and thus one must see in special relativity the beginning of a new era in epistemology and the methodology of science (though it is often seen first in the rise and influence of general relativity doing away with Euclidean space as the 'only' possible one).

There is no doubt that Einsteinian space-time relativity gives rise to serious difficulties to the understanding. Everybody sees the bodies of the world change their situation, not only spatially, but also in every aspect of their (macroscopic) physical state; and all these changes take place in the course of time. Therefore, it appears most natural that physics should have developed in the form of the study of temporal changes, of 'evolution'—evolution referring merely to lifeless matter, as contrasted with biology. In this representation is to be found the core of the mechanical conception of the world; and so it is not only a question of Newtonian

mechanics based on Galilean relativity having been taught at school, for about three centuries, that has made it so difficult for us in the twentieth century to appreciate the meaning of relativity: a natural relation of our intelligence to the things of the external world drives us towards a Galilean conception instead of the better, newer one. (The fact that Galilean relativity was not expressly recognized in times prior to Newtonian mechanics is connected with the lack of the mathematical means to formulate it.) Nevertheless, the force of habit is far from negligible, and there is no doubt that teaching the same theories in the schools for many generations makes us believe them to be the expression of a matter of evidence.

Neither an experiment nor a contradiction had for years invalidated that semblance of evidence—until Michelson's experiment and the discovery of the lack of Galilean covariance in Maxwell's electrodynamics.

The necessity of acknowledging the new evidence after having believed in the evidence of a state of mind always comes as a great shock. But it is wholesome for the spread of knowledge that we should learn about the frailty of formulae which one might imprudently confuse with absolute truths. Two reasons, therefore, make it psychologically understandable that from the very beginning Einsteinian relativity met with great opposition from many quarters: namely, the force of habit in connexion with that fallacious evidence, and the natural feeling for temporal evolution.

Indeed, the latter point—temporal change of state—is not fallacious. Einsteinian relativity is not anti-mechanistic, but it takes away from time the character of being a (mathematically) independent variable and assigns it to another parameter which is no longer intuitive.

The acceptance of Einsteinian space-time relativity was due to the condition imposed on light propagation, and consequently for Maxwell's electromagnetic equation to remain unchanged in form in the course of co-ordinate substitutions. But the co-ordinates included time, and so the frame of Newtonian mechanics had become untenable; bearing in mind that Newtonian mechanics had been elaborated for the description of gravitation, it is understandable that the acceptance of (special) relativity should be bound up with a renunciation of the ability to describe gravitation. That left a considerable gap in physical theory. Einstein realized this, of course, and as soon as the main problems of special relativity were solved, he set about generalizing it in a way which would render possible the description of gravitation.

Now all known interactions of matter can be reduced to a few elementary interactions, each having its intensity characterized by a universal interaction constant. The two most important are gravitation (with the constant of gravitation) and the electromagnetic interaction (with the so-called dielectric constant of vacuum as the universal constant). All elastic, crystalline, molecular and atomic properties, for example, can be reduced to the latter. It is known to-day that the cohesion and radioactivity of nuclei go back to a third sort of elementary interaction for which a good theory is still lacking, but for which a universal constant, such as that which Fermi once introduced in his theory of β -radioactivity, will take over the role of settling its intrinsic intensity.

It is very curious that the first step made by Einstein pushed aside, so to speak, every reference to one of these fundamental interactions, namely, to gravitation, and was only suited to the electromagnetic one. He recognized that this was due to the restricted use of the so-called Galilean reference frames and the definition of (pseudo-) Euclidean geometry, and the old idea, already suggested by Riemann and by Clifford, of description in non-Euclidean spaces occurred to him. It is difficult not to be convinced by the idea, because (1) the passage from Euclidean to Riemannian geometry allows us to take over the fundamental postulate of covariance of laws; (2) the Euclidean case of special relativity appears in relation to the more general Riemannian one like the tangent to a curve and therefore as the approximation where curvature vanishes; and (3) the appearance of curvature of Riemannian space offers exactly the field where gravitation can once again be described. But—and it is as if it were a trick played at our expense by our own theoretical pursuit—the electromagnetic case does not find a natural place in the theory of relativity thus generalized.

So, on one hand, the theory of general relativity (in its original form at least) lost more or less the advantage that special relativity had gained. Its aim was to reassemble, to unify in a completely coherent manner, the descriptions of two different interactions. The first attempt led to a failure, and electromagnetism had to be reintegrated artificially—an unsatisfactory process in a theory which was defined as unified. So began the search for unitary field theories which is not yet ended, as no unitary theory yet proposed has been definitely recognized as the right one. On the other hand, the elaboration of general relativity revealed the theoretical possibility of world expansion, and the very fact that world expansion was suspected experimentally suggested the adoption of a fourth interaction with the cosmic constant as the measure of its intensity.

In that way, we are led to the two remaining principal aspects of relativity theory: to cosmology in the study of gravitation and world expansion, and to the search for unified field theories.

The general theory has been experimentally sustained in its cosmological consequences by some measurements; but we are very far from an experimental verification comparable with that of Newton's mechanics, with its precise account of Kepler's laws which were based on innumerable measurements collected by Tycho Brahe, or with Bohr's atomic theory, with its account of Balmer's formula and the like based again on countless experimental results. The movement of the perihelion of the planet Mercury could be explained by some queer law of force; the deflexion of light and the displacement of spectral lines are still feeble confirmations compared with what has been done in other fields of physics. Therefore, I should like to stress the importance which *reason* has had in the acceptance of the theory of relativity. Here again, excessive positivism has been destroyed. The dignity of pure theoretical speculation has been rehabilitated; not in the form of an arbitrary speculation, but based on a process of the mind with its own justification, which I should like to call the 'experience' of the theory.

Despite these remarks, it is not to be concluded that general relativity has no experimental background whatsoever. It is not merely an empirical science, though it is not pure mathematics; it is the

prototype of that theoretical endeavour which is one of the characteristic features of our scientific century. For this reason, Einstein is largely responsible for the moulding of contemporary thought.

General relativity has thus several bearings on philosophy. In the published literature, the substitution of non-Euclidean for Euclidean geometry has been insisted upon almost invariably. It lays considerable weight, of course, on the formation of the *Weltanschauung* and the like, and it requires (after space-time relativity had already done so) a renewed effort to overcome the old conception of naïve intuition. Moreover, general relativity (like, and still more than, special relativity) has reminded the philosopher of the Platonic adage of the ΕΙ Ο ΘΕΟΣ ΓΕΩΜΕΤΡΕΙ: it has saved science from narrow experimentalism, it has emphasized the part which beauty and simplicity must play in the formulation of theories of the nature of the physical world,

and it has reinforced the conception of Heinrich Hertz that physics gives only models of that physical reality. But at the same time it has considerably modified this conception, because the models are no longer plainly mechanical: mathematics is the store where models are to be found, so mathematical abstraction is a necessary source even of positive knowledge.

In a sense, the theory of relativity is the fulfilment of classical physics so far as Newtonian determinism and Cartesian tradition are concerned. This alone would give it the right to praise; but in another sense, the theory of relativity is a liberation from classical physics on account of the completely unforeseen horizons it has opened up. It has afforded a liberation from crystallized criticism of science and towards unsuspected greatness, which amply justify us in commemorating the jubilee of its announcement.

RADIO RESEARCH STATION, DITTON PARK, BUCKS

By Dr. R. L. SMITH-ROSE, C.B.E.

ON May 16, representatives of technical staffs in the radio industry visited the Radio Research Station (Department of Scientific and Industrial Research) to meet the members of the Radio Research Board and its committees, and to inspect the work in progress at the Station. A wide range of exhibits and demonstrations was provided in the huts and temporary buildings of the Station at Ditton Park, near Datchet, Bucks.

It was following the Board's advice, given in 1946, that the Department of Scientific and Industrial Research accepted the recommendation of its Advisory Council that the programme of research previously conducted in the Radio Division of the National Physical Laboratory should be greatly expanded and administered independently under a new Radio Research Organization. Accordingly, in December 1947 the present writer was appointed director of the new organization, to which the radio staff of the National Physical Laboratory were later transferred. After reviewing the needs of the research programme and considering a number of alternative possibilities, the Radio Research Board endorsed a recommendation that the permanent site of the Radio Research Station should be at Ditton Park, in the grounds of the Admiralty Compass Observatory, where nearly 100 acres of the park have been used for field experimental work in radio over a number of years. In order to preserve the technical qualities of this park, another 100 acres of the neighbouring farm have been purchased by the Ministry of Works, mainly to ensure that the whole site is kept free from undesirable electrical interference with the radio research work. A small portion of it may be used for experimental work; but apart from this, the additional land will continue to be available to the farmer.

Research Programme

The programme of the Radio Research Organization is designed to assist in the solution of some of the problems which confront the various users of radio waves and radio-frequency techniques, whether for civil, military or industrial purposes. The major portion of the work for the past few years has been

concerned with meeting the needs of the communication, broadcasting and radio navigation services, by studying the propagation of radio waves along the ground and through the lower and upper atmospheres, and taking account of the various types of disturbance caused by atmospherics of natural origin and by interference due to electrical equipment. Other portions of the programme include an investigation of the physical properties of certain materials, such as semiconductors and ferromagnetic compounds, which are of special interest in the radio field. The measurement of power and field-strength, particularly in the upper bands of radio-frequency, is also the subject of study and development.

Measurements are being made of the speed with which radio waves travel over land and sea, and the results correlated with geological structure and ground conductivity. The effects on wave transmission of irregularities in the ground and the presence of natural or man-made obstacles, such as hills, trees and buildings, are studied with the view of determining, for example, the probable service area of new television stations at increasingly higher frequencies.

The transmission of very short waves to distances beyond the horizon is largely determined by the vertical gradient and regularity of temperature, pressure and humidity in the lower atmosphere or troposphere. A long-term investigation is in progress on the relationship between radio and meteorological conditions in order to obtain the information required in assessing the performance of communication, broadcasting and television services; and especially for the future planning of such services, including radio links, at wave-lengths from a few metres down to a few centimetres.

The Radio Research Station is responsible for the maintenance of seven observatories, two in the United Kingdom and five on British territory overseas, which make a continuous study of the characteristics of the ionosphere by the vertical sounding technique. The results obtained at these observatories and at some seventy-five others maintained by other countries are used in the preparation of forecasts of radio transmission conditions all over the world, six

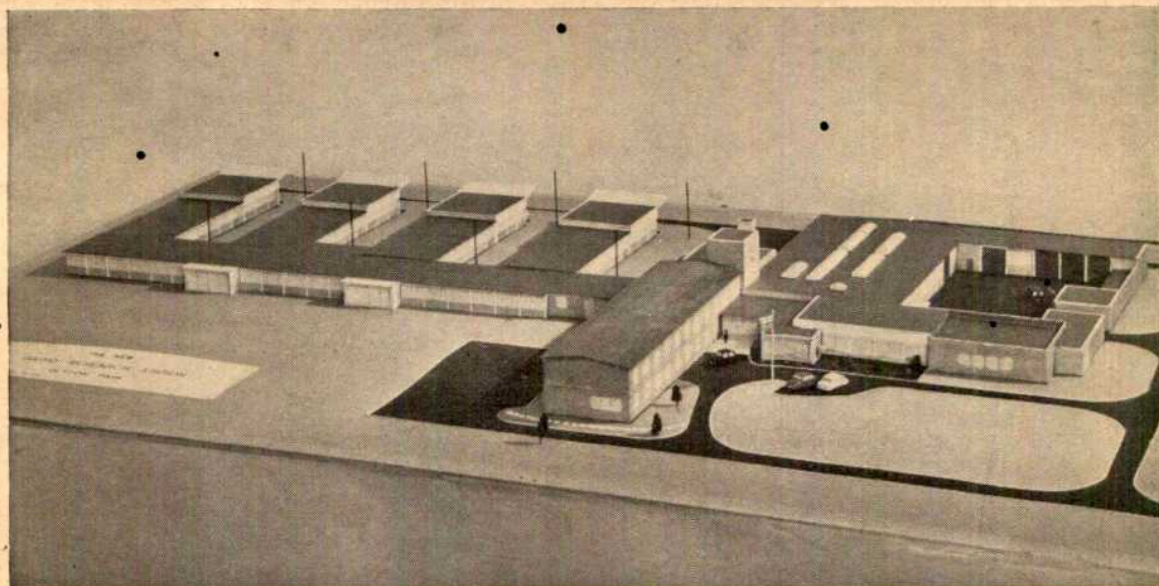


Fig. 1. View of model of the new Radio Research Station from front.

months in advance. These forecasts are used on a wide scale by organizations operating broadcasting and communication services and by air and marine navigation services.

The technique of sounding the ionosphere has recently been extended to points remote from the observing station by measuring the characteristics of echoes received by a combination of ionospheric reflexion and scattering from the ground at distances up to 10,000 km. (6,000 miles) or more. The study of the nature, time and direction of arrival of such echoes is greatly increasing our knowledge of the manner in which radio waves are transmitted to great distances around the world.

The scope of the various radio services is frequently restricted by the background of noise against which the signals have to be observed. Much of this noise is due to atmospheric disturbances arising in thunderstorms and lightning flashes. Measurements of the intensity of this noise are made in various parts of

the world with a uniform type of apparatus designed by the Radio Research Station. The characteristics of this disturbing noise are also under continuous investigation in order to develop means of mitigating its effects. Other apparatus for locating the sources of these atmospheric disturbances has been developed and is used by the Meteorological Office for supplying information on the position of storm centres for use in weather forecasting. An equipment for counting lightning flashes is under development in order to assist the meteorologist to supply information on the frequency and distribution of thunderstorms—information which is itself requested by the radio scientist.

Most of the apparatus required for these and similar investigations is of a highly specialized nature, and has been developed entirely at the Radio Research Station. In some cases, where the equipment is of interest to other users in Britain or abroad, a commercial firm has been assisted in reproducing it. Examples of such manufacture are the iono-

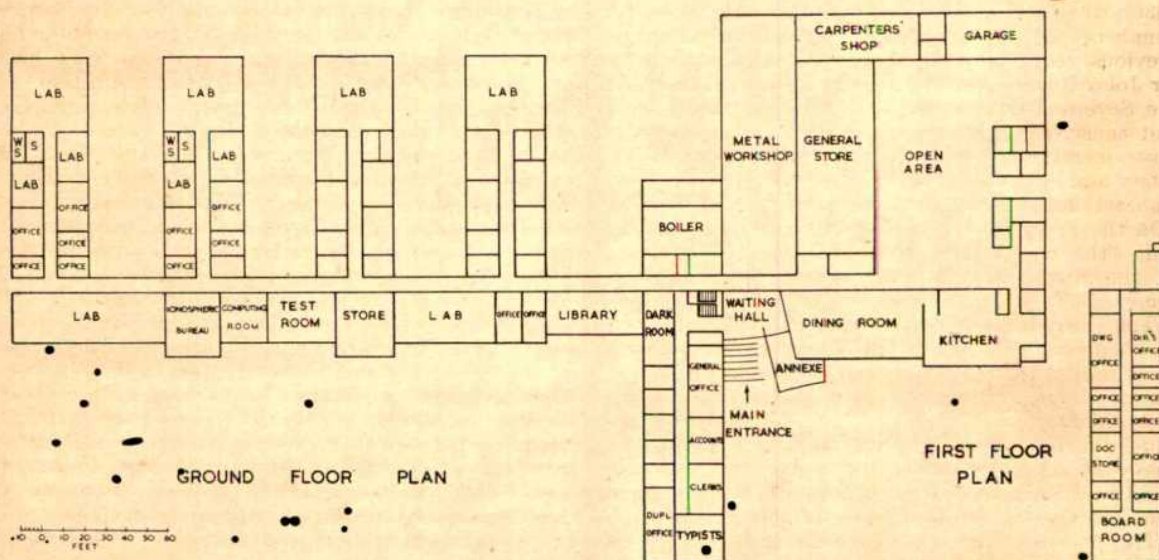


Fig. 2

spheric recording equipment, which is entirely automatic in operation, the cathode-ray direction finder for locating sources of atmospherics and the apparatus for measuring the strength of atmospheric noise on high and medium radio-frequencies.

New Buildings

The work of the Radio Research Station has hitherto been carried out in a number of temporary buildings which have been adapted with varying success to the needs of the research programme. With the expansion resulting from the Department's post-war programme, a permanent building has been designed by the architects of the Ministry of Works specifically to meet the research needs, and this building is now in course of erection. As will be seen from the accompanying photograph of a model (Fig. 1), the building will have at one end a two-story administrative block, together with all general services, workshops, stores, garages, dining room, etc., on the ground floor. The main portion of the building, containing the scientific laboratories, is of a single-story type with a backbone and four spurs, the ends of which open directly on to the field, which is regarded as a continuation of the laboratory space (Fig. 2). To make the best use of the field for experimental work, the building has been set to one side of the West Park, and every effort is being made to restrict the permanent metalwork in this and the other fields to the absolute minimum, so as to avoid any interference with the experimental work. A non-metallic pipe has been installed across the field to connect the waste outlet from the building with the main sewer, which itself is of non-metallic construction for the section across Ditton Park. The

electric power supply for work in the field will be obtained by temporary connexion to one of a number of distribution outlets from a ring-main around the periphery. In order to reduce radio interference from the ignition systems of motor traffic to the minimum, the building is sited at a distance of more than 200 yards from the nearest public road, and most of the working parts of the fields in use are nearly half a mile from any major road carrying vehicular traffic.

Various huts of a temporary and transportable nature will also be used for field-work, the position of these over the land area available being determined by the nature of the experimental work, the size of the aerial systems required and the need to reduce mutual interference between investigations in the same vicinity. For special types of research, the use of isolated sites away from the Station will continue as in the past; and in some cases the work is conducted in various parts of the country in vehicles equipped as mobile laboratories. To facilitate the installation and calibration of apparatus in these, a covered space is provided at the end of each spur of the main building, so that the work can be conducted directly from the appropriate laboratory.

The present staff of the Radio Research Organization numbers just over a hundred. Most of these are now in temporary accommodation at Ditton Park; due to the insufficiency of this accommodation, however, a small number still work at the National Physical Laboratory, Teddington. When the new building is ready for occupation, all the staff will be brought together at the Radio Research Station, and a steady increase in their numbers may be expected to take place over the next few years to deal with the expanding research programme.

BRISTOL MEETING OF THE BRITISH ASSOCIATION

DURING the week August 31–September 7, the one hundred and seventeenth annual meeting of the British Association will be held in Bristol. This is the fifth occasion that the Association has met in Bristol, and all concerned with the arrangements are aiming at a meeting that will stand comparison with its predecessors.

Bristol was host to the British Association first in 1836, when Prof. Daubeny, of Oxford, addressed members on the progress of science during the previous year. In 1875 the presidential address by Sir John Hawkshaw, railway engineer and builder of the Severn Tunnel, was given in the Colston Hall, and considered whether nationalization of the railways might not be in the best interests of public safety and national economy. At one of the sectional transactions, Prof. Stanley Jevons read a paper "On the Progress of the Coal Question", concluding that "the coal famine of 1872–3 may be regarded as the first twinge of the scarcity which must come . . .".

The third Bristol meeting was held in 1898 with Sir William Crookes as president. His address dealt first with world food supply, but went on to discuss progress in pure science, particularly in his own chief interest molecular physics, saying "the store drawn upon naturally by uranium and other heavy atoms only awaits the touch of the magic wand of science to enable the Twentieth Century to cast into the shade the marvels of the Nineteenth".

The president for the fourth Bristol meeting, in 1930, was Prof. F. O. Bower, who, with Dr. R. E.

Slade, showed how chemical science had helped to avert a world famine forecast by Sir William Crookes in 1898.

A brief glance at the preliminary programme will confirm that the high standard set by previous Bristol meetings has been maintained this year, and it will be interesting to see what new prophecies are forthcoming or what solutions have been found to age-old problems. This year's president, Sir Robert Robinson, is one of the world's greatest organic chemists, particularly noted for his research into the pigments of flowers and into the constitution of penicillin. At the inaugural general meeting he will speak on "Science and the Scientist", and as he is famed for being direct and candid, his audience at the Colston Hall can be assured of a lively and forthright address. During the week, as in past years, there will be television broadcasts of several items in addition to the usual sound broadcasts.

At the Colston Hall, the fourth to bear the name, and of them all the most perfect acoustically, there will be three evening discourses. The first of these will be given by Prof. C. F. Powell, of the University of Bristol, on "Experiments at Great Altitudes with Free Balloons", and will deal in part with nuclear physics in the very high-energy region. Prof. H. D. F. Kitto, professor of Greek in the University of Bristol, will give a discourse on "Scientific and Dramatic Modes of Thought", and Mr. B. J. C. Atkinson, of the Department of Prehistoric Archaeology of the University of Edinburgh, will speak on "Stonehenge in the Light of Recent Research".

Among the addresses by presidents of Sections, mention may be made of Prof. N. F. Mott's to Section A on "The Physics of the Solid State", Sir Alexander Todd's to Section B on "Nucleic Acid Structure and Function", Dr. D. B. Harden's to Section H on "Anthropology: a Scientific Unity?" and Mr. J. E. Wolfenden's to Section L on "The Educated Man in 1955".

It is impossible to set out all the presidential addresses in this short article, or to mention in detail the many and varied subjects to be covered by the sixteen sections, but the programme contains something for everyone, scientist or layman—and possibly too much for the ardent enthusiast, who cannot hope to partake of all the fare provided. The sectional meeting rooms will be within short walking distances of the Reception Centre, and with one or two exceptions will be located in departments of the University. The reception room and administrative offices of the Reception Centre will be in the Victoria Rooms, which will also house an exhibition illustrating the work of the British North Greenland Expedition. Mr. R. A. Hamilton, chief scientist of the Expedition, will give a public afternoon lecture in the Colston Hall on "The Scientific Work of the British North Greenland Expedition", and other scientific members of the expedition will participate in the proceedings of certain sections. Another afternoon lecture to be given in the Colston Hall will be that by Mr. B. J. Mason, of the Department of Meteorology of the Imperial College of Science and Technology, London, on "Man's Influence on the Weather", dealing with progress and possibilities in weather modification.

In past years, scientific films have been shown at section meetings, and the last morning of the meeting has been devoted to the showing of films of scientific interest. This year, because of the interest shown at recent meetings and in view of the increasing importance of the film in scientific work—not least as a medium for the interpretation of science to the layman—it has been decided, with the aid of the Scientific Film Association, to have daily continuous screenings of outstanding scientific films in sessions of about three-hours duration in a film studio at the College of Technology in Unity Street. These sessions will be on a "News Theatre" basis, and visitors will be at liberty to wander in—and out—whenever they please.

On two evenings the City Museum will be open to members who might wish to consult the curators or examine the extensive collections. While the collections refer primarily to the West of England, it should also be noted that the archaeological objects include Egyptian antiquities with the emphasis on the pre-dynastic and early dynastic periods, and some fine Greek vases. The ethnographical collections include Maori tattooed heads and a bronze head from Benin. The geological gallery was unfortunately destroyed in an air-raid in 1940; but the Channing Pearce and Tutchet collections, both of which are rich in Mesozoic fossils from the West Country, are worth noting. The Lewis Collection of Somerset birds' eggs and nests is outstanding, and there are extensive collections of British shells. Among the insect collections there are several of British Lepidoptera which are specially interesting, as also is the Barton collection of Buprestidae. The Bristol Naturalists' Society is arranging a special exhibition on the two evenings on which the City Museum is open. While in Bristol many members will undoubtedly visit the Blaise Castle House Folk Museum

and Folk Park, situated in a magnificently wooded estate of some 400 acres. The Folk Museum is a branch of the City Museum and contains collections ranging from the fifteenth to the nineteenth centuries illustrating English social and cultural history, with especial reference to the West of England.

This year's visit of the Association coincides with the eight-hundredth anniversary of the granting of Bristol's first charter by King Henry II. and a special exhibition to mark the occasion will be displayed in the City Museum. In addition, Prof. David Douglas, professor of history in the University of Bristol, will comment on the granting of the charter in his Saturday evening lecture at the Colston Hall on "The Living Past" and will discuss the contribution to be made by historical studies to the progress of the arts and sciences.

Scientists like other mortals must needs eat, and the local executive committee is doing its utmost to anticipate and meet the demands of even the most fastidious. Provisional block bookings of accommodation in hotels and boarding houses in the City have already been made, and the accommodation in Wills Hall (a university hall of residence), three theological colleges, and the Y.W.C.A. and Y.M.C.A. hostels in the City have been reserved. Owing to the demand for hotel accommodation in Bristol, however, the block reservations cannot be held after June 30 unless a definite booking has been received by the hotel from the individual member.

On the lighter side, Bristol has done its best to compile an attractive programme of excursions, both general and sectional, covering a fairly wide area of the south-west. In and around Bristol, visits will be made to many places of archaeological, historical and industrial interest, and several firms and organizations have generously come forward with offers of hospitality in various forms which will undoubtedly add to the success of the meeting. The steamer excursions should provide a wonderful opportunity for relaxation.

One may perhaps add here that, in common with the Association's hosts in other cities in recent years, the Bristol Local Executive Committee is at present producing a scientific survey of the region, the whole cost of which will be borne by the local fund and which will surely prove an informative and invaluable souvenir of the meeting. While the venue of this year's meeting is Bristol, it should not be forgotten that neighbouring authorities are also contributing, though necessarily to a lesser degree, to the success of the local arrangements. For example, the Schools Science Exhibition which members will see in the College of Technology would not have been possible without the whole-hearted co-operation of the local education authorities, particularly as the exhibits will have been staged during the holiday period. This is the first occasion on which such an exhibition has been arranged in connexion with an annual meeting of the British Association, and is an indication of the increasing interest in scientific achievements.

Of recent years Bristol has earned the reputation of being a 'City of Flowers'. During the period of the meeting the beautiful floral displays will be at their best in the parks, at the City Centre, in patches of loveliness by footpaths and in the streets, and in hundreds of window-boxes and hanging baskets. For 'spectacle and perfection, however, members should visit the annual horticultural show in the lovely natural setting of Durdham Downs during the first three days of the meeting.

OBITUARY

Prof. Albert Einstein, For.Mem.R.S.

EINSTEIN was unquestionably the most famous scientist of modern times. There can be little doubt that he was also the greatest and that he was one of the very great thinkers of all time. He changed some of the most fundamental concepts in our thought about the physical world; to very few has it been given to do this. What was most significant in his work may appear simple and inevitable in retrospect; but it resulted from his having questioned some of the universally accepted physical assumptions that no one had ever challenged before.

Albert Einstein was born of German Jewish parents, on March 14, 1879, at Ulm in Württemberg. He was educated at schools in Munich and at Aarau in Switzerland, and at the Federal Polytechnic School in Zurich. Having failed to obtain a teaching appointment, he found employment in the Swiss Patent Office in Berne. While holding a junior position there during 1902-8 he produced much of his most remarkable work, and an international gathering of scientists will meet at Berne this summer, at the invitation of their Swiss colleagues, to celebrate the jubilee of relativity theory. It is to the credit of the scientific world of the time that Einstein's early work was so readily published and given recognition. He was appointed successively *Privatdozent* in Berne (1908), extraordinary professor in Zurich (1909), professor of theoretical physics in Prague (1911), professor of theoretical physics in Zurich (1912) and director of the Kaiser Wilhelm Physical Institute and professor in the University of Berlin (1913). In 1933, when his position in Nazi Germany had become untenable, he accepted a professorship at the Institute for Advanced Studies in Princeton, which he held until his retirement in 1945, having meantime become an American citizen. He died at Princeton on April 18. In 1952 he had declined an invitation to become president of Israel. Einstein's first marriage, to Mileva Maritsch, by whom he had two sons, was dissolved, and in 1917 he married his cousin, Elsa Einstein, who died in 1936. He was awarded the Nobel Prize for Physics in 1921, the Copley Medal of the Royal Society in 1925, and very many other honours.

From an early age, Einstein had an unerring discernment of the fundamental problems in physics and a determination to devote himself to them. He was able to see ahead, even if only in broad outline, the main stages of what he set himself to achieve. In the tactics of research he was an opportunist, as in the help he got (and acknowledged) from Minkowski's geometrical ideas and from Ricci and Levi-Civita's tensor calculus, as well as in developments suggested by his own work. But he had a strategic plan that was all his own and to which he adhered. Although each of his major achievements was astonishingly complete in itself, in his view it was the gain of a limited objective that was to serve as a base for the next advance.

Einstein started his scientific work with a realization of the inadequacies of Newtonian mechanics both in its own fundamental formulation and also as a basis for physical theory in general. Many of the considerations were well known, but what impressed Einstein most was the fact that the rudimentary concepts of mechanics and of electrodynamics are so different. Moreover, about this time, Planck had

given his theory of temperature-radiation and energy-quanta, and Einstein saw that it involved fundamental contradictions of both classical mechanics and electrodynamics.

The basic notion of electrodynamics is the 'field' and of mechanics it is the 'particle'. In the perplexing situation of those days and ever afterwards, Einstein expected progress to result from the further development of 'field-theory', or of the 'electromagnetic foundation of physics' as he called it, obviously using the expression in a very general sense. But he knew that he must always look for ways of accommodating the 'particle' aspects of physics.

Of all existing physical theory at that time, only classical thermodynamics seemed secure within its own domain and to offer a safe starting-point for fundamental investigations. So it was natural that Einstein's first papers (1901-5) should be on that subject and in particular on its statistical formulation. This led to his famous discovery (1905-6) of the true nature of Brownian movement as a manifestation of the heat-motion of 'molecules', a notion which it crucially vindicated, and his demonstration of the consequent possibility of determining molecular dimensions.

Einstein then observed that a mirror suitably suspended in an enclosure of temperature-radiation ought, in principle, to possess Brownian movement with mean energy appropriate to the temperature. This he showed to be incompatible with electromagnetic wave theory. On the other hand, he was able to show that it is consistent with the hypothesis that radiation of frequency ν interacts with matter, and is propagated, only in whole quanta of energy $h\nu$, where h is Planck's constant. He had already realized that this hypothesis would explain the observational properties of the photoelectric effect. These ideas he developed in his paper of 1905, which presented the concept of light-quanta in the form employed ever since. It freed Planck's ideas about energy-quanta from association with real or hypothetical oscillators and transformed the concept into one having universal physical significance. In this paper, Einstein also suggested that the wave-character of radiation could be treated as a statistical feature of its corpuscular character. Natural though this suggestion may have been, it was the first step towards reconciling the wave and particle aspects of physics, and so towards modern quantum mechanics. But Einstein called all this merely a "heuristic viewpoint".

He was convinced that true progress depended upon starting much further back. He set himself to find a new principle on the model of the thermodynamic principle requiring the laws of physics to be such that it is impossible to achieve perpetual motion of the 'first' or 'second' kinds. He recorded that it took him from the age of sixteen to twenty-six to find it in the form, coupled with the assumption of the constancy of the speed of light, requiring the laws of physics to be such that it is impossible to detect uniform motion relative to an inertial frame of reference (save, of course, by direct observation of the frame). The paper, also of 1905, in which Einstein developed the consequences of this principle could even to-day be given to a student as probably the best summary of the theory of (special) relativity. Remembering his preoccupation with the electromagnetic foundation of physics, it may be recalled that the title of the paper is "On the Electrodynamics of Moving Bodies".

Many features of the theory had been foreshadowed by other workers. In Einstein's intensely original presentation, these features fell into place in a system based upon a single principle. Moreover, Einstein saw a significance in the work that was beyond the range of vision of his predecessors. Their merit was in having so exposed the difficulties of the matters concerned that the magnitude of Einstein's achievement could the more readily be appreciated.

It was another ten years before Einstein attained what was almost certainly his greatest triumph, the theory of general relativity. The restrictions in the scope of the special theory are well known, as are also some of the considerations, particularly in regard to the equivalence of inertial and gravitational mass, that guided Einstein in removing the restrictions. He was guided also by Minkowski's geometrical formulation of special relativity. But in general relativity the geometry of space-time and what is happening in space-time are interdependent; hitherto it had been universally assumed that space-time had an independent existence. If ever any single advance may be called epoch-making, this is one that must earn the description. In whatever way physical theory may develop in the future, it cannot be believed that this step will ever be retraced. For it is easy to recognize that the behaviour of clocks, measuring-rods and light-signals must be related to the behaviour of the physical system of which they form part. It had previously been implicitly supposed that there nevertheless exists an underlying space-time that can somehow be 'explored' by the use of the measuring-rods, etc. In effect, Einstein showed the emptiness of this concept. When we consider what we call the spatial and temporal relationships of a physical system, we are concerned with aspects of its behaviour that cannot be conceived in separation from its other aspects.

It was one thing to appreciate the advance that was needed; it was another to give it mathematical expression. Einstein accomplished this in brilliant fashion in the limited domain of the 'general' theory. For he regarded this as being satisfactory only in its treatment of a pure gravitational field. He described as only 'makeshift' the way in which he introduced the matter-tensor. According to his view, in this provisional state of the theory, material bodies are essentially regions where his gravitational field-equations ($G_{\mu\nu} = 0$) are not satisfied, and so, in this sense, the bodies are singularities in the field. In 1938 and succeeding years, Einstein and his collaborators improved upon the original formulation of the theory to the extent of showing that the motion of such singularities in each other's presence is determined by the field-equations alone. Thus general relativity has no need to postulate equations of motion in addition to the field-equations, by reason of the non-linearity of the latter. However, Einstein's ultimate aim was to obtain field-equations such that actual physical systems correspond to solutions free from singularities. He believed this would be possible if, and only if, he could represent all physical forces, electromagnetic and nuclear as well as gravitational, in the theory—hence the name 'unified field theory'. If successful, such a theory would account for the existence of material particles in terms of the field and so, in the most fundamental manner that Einstein could envisage, it would reconcile these aspects of reality. In doing so, he further believed, it would reproduce 'quantum' effects, but without the need for the

statistical interpretations to which he objected in current quantum theory. After various discarded attempts, he thought the field-equations which he proposed in 1949-51 to be "the most natural generalization of the equations of gravitation". Whether these equations possess solutions free from singularities has not yet been determined.

The problem of unifying the basic concepts of physics has, of course, the importance that Einstein thought. However, most physicists expect it to be solved rather by a generalization of quantum theory than by the opposite approach attempted by Einstein. His view and comments by its leading critics are to be found in "Albert Einstein: Philosopher Scientist" (edit. P. A. Schlipp, New York, 1949, 1951). Here it need only be said that Einstein's position should be judged only in the light of his doctrine of concepts as being "freely chosen conventions".

Besides the main development of his work, Einstein made numerous other important contributions. These include, for example, the 'Einstein coefficients' in connexion with atomic transition-probabilities, his work from which the Einstein-Bose statistics emerged, and his enunciation of the 'Einstein universe' and other contributions to relativistic cosmology.

Einstein was deeply and increasingly concerned about world affairs. In the First World War he took a courageous stand as a pacifist in Germany. However, he could not but approve of the war against Nazism, and in 1939 he sent a historic letter to the American President warning him that Germany might succeed in manufacturing an atomic bomb. He became a leading spokesman for Jews throughout the world, particularly in regard to their return to Palestine. He was for long an advocate of world government. His opinions on these matters and his attitude towards philosophy and religion are expressed in the collection of essays "Out of my Later Years" (New York and London, 1950).

Einstein's gifts inevitably resulted in his dwelling much in intellectual solitude. While he was not sociable in the usual sense, he had a penetrating understanding of his fellow-men. Music played a great part in his life, and the satisfaction it gave him he gladly shared with his friends. The many tributes paid to his personality all testify that his moral stature matched his intellectual pre-eminence.

W. H. MCCREA

My first contact with Einstein was at the eighty-fifth meeting of the German *Naturforscher-Versammlung*, held in Vienna in September 1913, when I was a postgraduate student in the Radium Institute there. In his usual attractive and friendly manner, he lectured to the Physics Section on "Gravitation", and his lecture quite obviously impressed most of his hearers as the work of a master-mind. But it was clear in the discussion which followed that many German-speaking men of science were not yet converted to his ideas. Doubts were expressed on the validity of his views on the equality of inertial and gravitational mass, on the velocity of propagation of gravitational processes, on the possibility of ever being able to detect the deflexion of light rays in a gravitational field or the predicted red-shift of spectral lines in such a field. The over-riding impression left on my mind was that the older generation was more sceptical than the younger and, indeed, several of these young men, then in their

twenties, later became distinguished workers in special and general relativity. But throughout the discussion Einstein remained smilingly unperturbed and said he was prepared to stand or fall by the results of an empirical examination of his predictions. He had not very long to wait, for when I translated his popular work on "Relativity" in 1920, I suggested to him that he might like to include an appendix on the experimental confirmation of the theory and he immediately agreed, there being already much experimental evidence available in his support.

Having finished one piece of work, he rarely returned to it, preferring to investigate fresh fields. Once the original proofs of his popular book were sent to press, I think it unlikely that he ever re-read the text, contenting himself with adding new appendices, the last of which appeared two years ago. Thus it was that a statement in the early editions, about the impossibility of testing empirically his mass-energy relation, remained uncorrected until two years ago, when, during proof-reading, I noted the oversight and was able to add a supplementary note to the relevant chapter.

His world-wide but unsought fame undoubtedly reached its zenith with the confirmation of his predicted gravitational deflexion of light rays by Eddington and others in 1919. This news caught the popular imagination and was a pleasant change from news of war. His first comments in Britain on the

results of the solar eclipse expeditions were published at the request of *The Times*, rather than in a recognized scientific journal. Referring to this in a letter to me, he wrote: "It cannot do any harm, for, thank God, the solar eclipse and the theory of relativity have nothing in common with politics. In this work, Englishmen of science have behaved splendidly throughout, and to my delight your letter shows me that the feelings of English colleagues have not been influenced as much by the war as one might have feared. Within the last few days I have had also from Eddington a very charming letter, about which I have been extremely pleased. I should like to utilize the favourable circumstances to contribute as much as possible towards the reconciliation of German and English colleagues". (My translation.)

I had been a civilian prisoner in Vienna throughout the First World War, but was allowed to continue my scientific work unhindered. Referring to this, Einstein wrote: "Your two letters have given me great pleasure and particularly the news that our Viennese colleagues treated you in such a friendly manner during the war". My next meeting with him was immediately after his lecture on relativity at the University of Manchester in 1921, when I had the pleasure of driving with Prof. and Mrs. Einstein and Dr. Erwin Freundlich in the environs of the city.

ROBERT W. LAWSON

NEWS and VIEWS

Linnean Gold Medal:

Sir John Graham Kerr, F.R.S.

THE award of the Linnean Gold Medal on May 24 to Sir John Graham Kerr has given great pleasure to a wide circle of colleagues and former students who have had the benefit of his stimulating and original personality, and also to a much wider circle of naturalists throughout the world. Sir John is one of the last of the great zoologists of the beginning of this century, who seemed to possess an almost encyclopædic general knowledge of the subject, as well as being a specialist in one or more branches. He started his career as a naturalist in the Linnean and Darwinian tradition, by joining an expedition to the Pilcomayo region of the Gran Chaco, Paraguay, during 1889-91. The years following this expedition were spent at Cambridge, where the School of Zoology then occupied an unrivalled position as a centre for the study of comparative morphology and embryology. He joined Christ's College as a scholar and after taking his degree carried out a second expedition to the Gran Chaco—during 1896-97—to study the little-known lung-fish, *Lepidosiren*. The account of these two famous expeditions—"A Naturalist in the Gran Chaco"—was only published in 1950 and has been described as the best book about South America since Charles Darwin's "Voyage of the Beagle". He was appointed regius professor of natural history in the University of Glasgow in 1902, when the chair still included geology—which, however, became distinct in the following year. He held the chair for thirty-three years and built up a great Department of Zoology and a very fine museum in which the exhibits were beautifully displayed on black backgrounds with indirect lighting. During these years, apart from his numerous publications and text-books,

he took an active part in public affairs and became chairman of the Glasgow Unionist Association and afterwards represented the Scottish Universities as M.P., 1935-50. He originated and communicated to the Admiralty in September 1914 the scheme for the protective coloration of ships by counter shading and strongly contrasting patches ('dazzle') based on his observations in the field.

The president of the Linnean Society, Lieut.-Colonel Seymour Sawell, in presenting the Medal, recalled that when he entered Christ's College, Cambridge, fifty-six years ago, Sir John was then a Fellow of the College and demonstrator in the Department of Animal Morphology, and he also referred briefly to the many distinctions of "the doyen of British zoologists". The Medal was received on behalf of his father by Mr. Ronald Graham Kerr, and the meeting expressed its deep sympathy with Sir John in his blindness, which prevented his attendance, and also their warm affection for him, both as an eminent scientist and Fellow of the Society, and a personal friend of long standing.

Applied Geophysics at Imperial College of Science and Technology, London:

Prof. J. McG. Bruckshaw

AS part of the expansion programme of the Imperial College of Science and Technology, London, an entirely new Department of Applied Geophysics has been established in an extension of the Royal School of Mines, where it will function in appropriate juxtaposition to the Departments of Geology and of Applied Geochemistry. In charge of the new Department will be the first occupant of the recently instituted chair of applied geophysics, Prof. J. McG. Bruckshaw, who has been largely responsible for instruction and research in geophysics within the

Imperial College for many years. Trained initially as a physicist under Sir Lawrence Bragg at the University of Manchester, he was attached by the Department of Scientific and Industrial Research in 1929 to the Imperial Geophysical Experimental Survey in Australia, where his interest in the use of physical methods of mineral exploration was first aroused. Two years later, on his return to England, he was enlisted by Prof. A. O. Rankine to help in setting up a school of geophysics within the Physics Department of the Imperial College, where it has continued to flourish progressively, especially during the past decade. His research activities have ranged far across the ever-widening field of geophysical prospecting, and he has enriched the literature by many pioneering contributions, notably on rock magnetism—a subject of profound academic and practical significance. Prof. Bruckshaw's diverse experience of geophysical surveys in many lands fits him well for the task of training students of geology and physics in the techniques of geophysical prospecting. At the same time, his intimate knowledge of field problems will enable him to direct research towards the twin goals of improved methods of subsurface exploration and of more reliable interpretations of geophysical anomalies. Under his guidance the Department of Applied Geophysics confidently expects to play an increasingly important part in providing skilled personnel to allay the growing demands of the mining and oil industries for help in the search for concealed mineral deposits at home and abroad.

Agriculture at Wye College, University of London: Prof. William Holmes

THE University of London chair in agriculture at Wye College, vacant since the appointment of Prof. M. McG. Cooper to the chair in King's College, University of Durham, is being filled by Dr. William Holmes, who comes from Kilbarchan in Renfrewshire, and is still in his early thirties. He was educated at the John Neilson Institution in Paisley and then took the degree course in agriculture of the University of Glasgow and the West of Scotland Agricultural College. He graduated in 1942 after winning several College medals and prizes, including the Weir of Courance Prize in advanced agriculture and the distinction of being the most successful final-year student; in the same year he was awarded the College and National Diplomas in Dairying. After becoming farm manager at the Hannah Dairy Research Institute, Dr. Holmes took a leading part in the work of the Institute which established the practicability of producing high yields of milk under war-time and other conditions of self-sufficiency in feeding-stuffs. This work had other important results, including a study of efficient utilization of pasture, and a convincing demonstration that unprecedentedly heavy applications of nitrogenous fertilizer to a ley could be economic provided the rest of the soil treatment was kept in balance. Dr. Holmes gained his doctorate for his share in these investigations, which have much interest for all concerned with the rational intensification of use of grassland.

Institution of Mining and Metallurgy: Awards

THE following awards have been made by the Institution of Mining and Metallurgy. *Gold Medal of the Institution*: Prof. W. R. Jones, past president of the Institution, in recognition of his services to the science of economic geology and to the Institution. *Honorary Membership of the Institution*: Sir Winston

Churchill; Mr. G. A. Denny, in recognition of his distinguished services to the mining industry of the Union of South Africa, notably in the early development of Witwatersrand gold mines; and Dr. J. B. Tyrrell, in recognition of his work in the exploration and development of the mineral resources of Canada. *Consolidated Gold Fields of South Africa, Limited, Premium of Forty Guineas*: Mr. G. C. Norris, for his paper on some grinding tests with spheres and other shapes (*Trans. Inst. Min. Metall.*, 63). *Arthur Clouet Student's Prize*: Dr. A. R. Barringer, for his paper on the preparation of polished sections of ores and mill products using diamond abrasives, and their quantitative study by point counting methods (*Trans. Inst. Min. Metall.*, 63).

The Gold Medal which has been awarded to Prof. Jones is the highest honour the Institution can confer. Prof. Jones, who is seventy-five, was educated at the Imperial College of Science and Technology, London, and spent his early career abroad, first for four years in the Colonial Service as first assistant government geologist to the Federated Malay States, then in Burma during 1916–19 as general manager of High Speed Steel Alloys Mining Co., Ltd., and later as managing director of the Malayan China-Clay and Pottery Co. In 1926 he returned to the Imperial College to work in the Geology Department of the Royal School of Mines, being successively demonstrator, lecturer, reader and, in 1941, professor of mining geology. He retired in 1947, when he was made an emeritus professor, and in the following year he was made a C.B.E. An important feature of his work has been his investigations into the causes of silicosis and pneumoconiosis among miners in South Wales; more recently he has been active as chairman of a working party appointed by the Government in 1946 to revive the china-clay industry in Great Britain, and as a member of the Mineral Resources Committee of the Ministry of Fuel and Power. Prof. Jones's connexion with the Institution dates back to 1916 when he became an associate member; for the past twenty years he has served continuously on the Council, holding the office of vice-president for the three sessions 1939–42 and president for the session 1947–48.

Télévision Service in Band III

THE first report of the Postmaster General's Television Advisory Committee (1952) made it clear that the future development of television services in Britain must take place in the higher bands of radio frequencies, of which Band III (174–216 Mc./s.) must be the first to receive attention. The Independent Television Authority has now announced that commercial television will start in London on September 22 from a transmitting station now being built at Croydon, Surrey, and designed to operate in Channel 4 (191–196 Mc./s.). The British Broadcasting Corporation has also ordered transmitting equipment for the provision of an alternative television service in Band III, and has applied to the Postmaster General for an allocation of channels in the Band.

In order to assist the manufacturers of television aërials and receivers to operate on the new frequencies coming into use in Band III, arrangements have been made by the Radio Industry Council, in co-operation with the Independent Television Authority for test transmissions to take place from a temporary station near Croydon. These experimental transmissions are now being made by Belling and Lee, Ltd., during 1030–1230 hr. and 1400–1600 hr. or

Mondays to Fridays, and 1000–1300 hr. on Saturdays. A vision signal of a suitable test card is provided on a frequency of 194.75 Mc./s., using a radiated power of about 1 kW. from a temporary mast 85 ft. high, using vertically polarized transmission. While both the power and the height of the aerial to be used for the Independent Television Authority's service transmitter will be considerably greater than these values, it is considered that the signals obtained over a radius of 10–20 miles from this test transmitter should be of considerable assistance to all those concerned with the development of television in Band III.

Organization of Agricultural Research

THE organization of agricultural research in Britain has recently been reviewed by the Government. As a result, the grant-aiding function hitherto exercised by the Ministry of Agriculture, Fisheries and Food has been transferred to the Agricultural Research Council. The financial and general administration, as well as the scientific direction, of the grant-aided agricultural research institutes in England and Wales will therefore be unified under the Council. The independent status of the grant-aided institutes will not be affected. So far as Scotland is concerned, the Government has accepted the recommendation of the Royal Commission on Scottish Affairs and no change will be made in the present arrangements, under which grants-in-aid are made to certain agricultural research institutes by the Secretary of State for Scotland, on the advice of the Agricultural Research Council. The importance of linking agricultural research effectively with the needs of the agricultural industry is fully recognized. To this end an order will be submitted for the approval of Her Majesty in Council, reconstituting the Committee for the Privy Council for Agricultural Research, so as to consist of the Lord President of the Council and the two agricultural Ministers. Close attention will continue to be given to the co-ordination of the work of the Agricultural Research Council on one hand, and the Agricultural Improvement Councils of England and Wales and of Scotland on the other. These changes will, it is hoped, be completed by March 31, 1956.

Peaceful Uses of Atomic Energy: British Exhibitions at Geneva

DURING the International Conference on the Peaceful Uses of Atomic Energy to be held in Geneva during August (see *Nature*, April 9, p. 615), there will be an exhibition of equipment, etc. Great Britain will be represented by two collections of exhibits. One will be of a purely scientific character and intended principally for members of delegations. It is being arranged by the United Kingdom Atomic Energy Authority at the Palais des Nations, and will cover an area of 3,000 sq. ft. It will be mainly concerned with nuclear reactors for research and for the generation of power, and with specialized instrumentation which Britain has developed in this field. The second exhibition, in the Palais des Expositions, will be open both to delegations and to the general public. In an area of 5,000 sq. ft., the United Kingdom Atomic Energy Authority exhibits will provide a general survey of the peaceful applications of atomic energy in Britain. The subjects presented will include Britain's first atomic power station, now being built at Calder Hall; the ten-year power station programme; isotope applications in industry,

medicine and agriculture; and nucleonics. Associated with this central feature will be exhibits presented by British firms concerned with atomic energy development. To co-ordinate the commercial exhibits, a central committee has been formed, under the chairmanship of Mr. Eric H. Underwood, director of public relations to the Atomic Energy Authority, and including representatives of the Federation of British Industries, the nucleonics industry, civil engineering contractors, boiler-makers and manufacturers of electrical and generating equipment. Mr. N. C. Pratt (Philips Electrical, Ltd.) is acting as honorary co-ordinator to the commercial exhibition committee. Inquiries of a technical character should be addressed to Mr. E. H. Underwood at the United Kingdom Atomic Energy Authority, St. Giles Court, 1–13 St. Giles High Street, London, W.C.2.

Research in the Belgian Congo

AN illustrated brochure has been issued by the Institute for Scientific Research in Central Africa, founded at Leopoldville, Belgian Congo, on July 1, 1947, describing the functions and organizations of the Institute and its activities and achievements during its first five years (pp. 14+13 plates. Brussels: Institut pour la Recherche Scientifique en Afrique Centrale, 1955). Its first task is to encourage studies by research workers in Belgian Central Africa and scientific visitors to the Congo; but it is also responsible for co-ordinating scientific work in the area and making it more systematic. Up to the end of 1954 the Institute had built up a staff of forty Europeans and four hundred Africans, and a central library at the Lwiro Research Centre, on Lake Kivu, Bukavu, consisting of sixteen thousand volumes. Its three main fields of research are the physical, biological and human sciences. The latter embrace physical and social studies of the African, including his nutrition and physical aptitudes and characteristics, political organization, culture and economy. Physical research is concentrated at Lwiro and Mabalé and includes astrophysical, solar radiation, geophysical and seismological studies, while biological work includes human nutrition and zoology at Lwiro, hydrobiology at Uvira, biochemistry at Elizabethville, and physiology and botany at Mbalé.

Mount Everest

TO the readers of any of the works on Mount Everest, a pamphlet in the form of a chart entitled "Everest: a Guide to the Climb", by James Champion (London: University of London Press, 1955; 1s. 6d.), should be welcome. It portrays the ascent of the mountain from 17,000 ft., indicating the main features of the route and the position of the camps. Mr. Champion has analysed the features of the climb clearly and comprehensively, and so has much increased the reader's appreciation of the almost insurmountable difficulties. The pamphlet also contains two pictorial sketch-maps of the topmost regions of the mountain, and there are short biographical notes on the climbers, including the Sherpas.

Beit Memorial Fellowships for Medical Research

BEIT Memorial Fellowships for Medical Research (junior fellowships worth £800 a year) have been awarded to the following for research at the institutions indicated: Dr. P. C. Caldwell, the mechanism of muscular contraction in Crustacea (Marine Bio-

logical Laboratory, Plymouth); Dr. R.-H. Côté, the chemical constitution of human blood group substances of the A, B and O Lewis systems (Lister Institute of Preventive Medicine, London); Dr. E. I. B. Dresel, the biosynthesis of porphyrin pigments (University College Hospital Medical School, London); Dr. J. M. Lowenstein, the biosynthesis of pyrimidines in mammals (Department of Biochemistry, University of Oxford); Dr. R. Whittam, the metabolism of adenine nucleotides in relation to the active transport of inorganic ions (Physiological Laboratory, University of Cambridge).

Bowen Prizes for Papers on Scientific Instrumentation

THE Institute of Physics has awarded Bowen Prizes to the following for papers published in the *Journal of Scientific Instruments* during 1954: Dr. K. P. Norris, of the Wheatstone Physics Laboratory, King's College, London (a reflecting microscope for infra-red absorption measurements); G. Revesz, of the British Rayon Research Association, Manchester (an autocorrelogram computer); and J. H. Welch, of the Building Research Station, Watford (a simple microscope attachment for observing high-temperature phenomena). The first award is worth 20 guineas, and the other two 15 guineas each, the money being provided by the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., from the Bowen Trust Fund established by the late Mr. William Bowen. The Prizes are open to authors who are not more than thirty-five years of age.

Nuclear Physics: Summer Course at Lake Como

THE third of the annual courses arranged by the Italian Physical Society at the Ente Villa Monastero, Varenna, Lake Como, will be held this year during July 17–August 6 and will be on nuclear physics. The course, which will be under the direction of Prof. C. Salvetti (University of Milan), will be in English and French, and lectures will be given by the following: Prof. A. Bohr (University of Copenhagen); Prof. S. de Benedetti (Carnegie Institute of Technology, Pittsburgh); Prof. G. Placzek (Institute for Advanced Study, Princeton); Prof. I. I. Rabi (Columbia University, New York); and Dr. A. M. Weinberg (research director at the Oak Ridge National Laboratory). The number of students is limited to thirty, and the fee for the course is 25,000 lire (or 20,000 lire for shared accommodation). Application must be made before June 10 to Prof. C. Salvetti, Società Italiana di Fisica, Via Saldini 50, Milano.

The Night Sky in June

FULL moon occurs on June 5d. 14h. 08m., U.T., and new moon on June 20d. 04h. 12m. The following conjunctions with the moon take place: June 3d. 09h., Saturn 6° N.; June 18d. 19h., Venus 3° S.; June 21d. 11h., Mars 3° N.; June 22d. 12h., Jupiter 4° N.; June 30d. 12h., Saturn 6° N. In addition to these conjunctions with the moon, Venus is in conjunction with Aldebaran on June 21d. 11h., Venus 4.6° N., and Mercury is in conjunction with Venus on June 30d. 08h., Mercury 3.8° S. Mercury sets at 21h. 35m. on June 1, but is too close to the sun for favourable observation during most of the month and is in inferior conjunction on June 16. Venus rises at 3h., 2h. 45m. and 2h. 40m. on June 1, 15 and 30, respectively, its stellar magnitude remaining –3.3

throughout the month; although the visible portion of its illuminated disk increases from 0.906 to 0.954, the stellar magnitude does not vary owing to the planet increasing its distance from the earth by 11 million miles. Mars sets at 22h., 21h. 40m. and 21h. 15m. on June 1, 15 and 30, respectively, but towards the middle of the month it is too close to the sun for favourable observation. Jupiter sets at 23h. 20m., 22h. 30m. and 21h. 40m. at the beginning, middle and end of the month, respectively; at the end of the month it sets less than an hour and a half after sunset and cannot be observed for long. Saturn sets in the early morning hours at 3h. 05m., 2h. 15m. and 1h. 10m. on June 1, 15 and 30, respectively, and has a retrograde motion in the constellation Libra. No occultations of stars take place in June which are visible at Greenwich. Summer solstice occurs on June 22d. 05h.

On June 20 a total eclipse of the sun takes place, which is invisible in the British Isles. The path of totality crosses the Indian Ocean, Ceylon, Thailand and the Philippines, and is total at Colombo, where it begins on June 20d. 01h. 37m. and ends at 3h. 59m., the total eclipse lasting from 2h. 40.7m. to 2h. 44.9m. The period of totality near the Philippines is about 7m. 08s., which is close to the maximum duration that is possible; it is the longest time of totality that has occurred or will occur in this century.

Announcements

PROF. W. H. BUCHER, professor of structural geology in Columbia University, New York, has been awarded the William Bowie Medal of the American Geophysical Union (the Committee on Geophysics of the National Research Council) for his work in the field of structural geology and mountain building. Prof. Bucher is the seventeenth recipient of the Medal, which was first awarded in 1939 to the late William Bowie, the geodesist and geophysicist, in whose honour the Medal is named.

DR. E. W. RUSSELL, reader in soil science, Department of Agriculture, University of Oxford, has been appointed director of the East African Agriculture and Forestry Research Organization, in succession to Sir Bernard Keen, who has retired (see *Nature*, January 29, p. 194).

THE following appointments have been made in the University of Leeds: Dr. E. R. Clark, lecturer in pharmacological chemistry in the Department of Pharmacology; Dr. P. G. Harris, lecturer in geology; and Mr. F. Summers, senior research worker in the Department of Social Studies for two years under the terms of a grant from the Coal Industry Social Welfare Organization.

MR. M. W. PARTRIDGE, at present lecturer in pharmaceutical chemistry in the University of Nottingham, has been elected to the Lord Trent readership in pharmaceutical chemistry in the University.

THE symposium on the tanning industry of eastern India and on tanning agents, which was to have been held this year at the Central Leather Research Institute, Adyar, Madras 20, during February 8–9, had to be postponed and will now be held during July 6–8. In the discussion on tanning agents the field will cover vegetable, synthetic, mineral, oil and aldehyde tanning agents. Advance copies of papers must be sent in by June 16. Further information can be obtained from the Director of the Institute.

THE U.S. NATIONAL ACADEMY OF SCIENCES

ANNUAL MEETING

THE ninety-second annual meeting of the National Academy of Sciences was held in Washington, D.C., during April 25-27 and was attended by more than two hundred members and their guests, with Sir K. S. Krishnan, president of the National Institute of Sciences of India and director of the National Physical Laboratory, New Delhi, as the guest of honour. Thirty-five papers were read at five sessions. Three other sessions were devoted to symposia on the following subjects: sound and its perception; biochemical pathways of energy transfer; and modern concepts in meteorology.

At the meeting the following awards of the Academy were presented: *Agassiz Medal*, to Prof. W. Maurice Ewing, director of the Lamont Geological Observatory and professor of geology at Columbia University, New York; *Elliot Medal*, to Dr. Libbie H. Hyman, research associate of the American Museum of Natural History, New York; *J. Lawrence Smith Medal*, to Dr. Peter M. Millman, head of the Section on Upper-Atmosphere Research of the Division of Radio and Electrical Engineering, National Research Council of Canada; and *Kimber Genetics Awards*, to Prof. William E. Castle, emeritus professor of genetics, Harvard University, and Prof. Hermann J. Muller, professor of zoology, Indiana University.

The Alexander Agassiz Medal, which is open to anyone for outstanding work in the science of oceanography, has been awarded to Prof. Ewing for his achievements in marine geophysics. During the Second World War he worked on underwater explosives and also on a system of long-range underwater sound transmission; more recently he has made important contributions to knowledge of the structure of the floor of the Atlantic Ocean and the continental shelf, and his underwater photographic techniques have greatly increased knowledge of conditions on the ocean floor in deep water.

The Elliot Medal, which is for the most meritorious work published each year in zoology or paleontology, has been awarded to Dr. Hyman for her two volumes, published in 1951, which are part of a treatise on "The Invertebrates", and are important not only to zoologists but also to teachers and to research workers concerned with medical matters, especially parasitism. Dr. Hyman is the first woman to receive this award since it was established in 1917, and is the second woman to gain an Academy medal.

Dr. Millman, who receives the J. Lawrence Smith Medal for "fruitful research in meteoric bodies", is a pioneer in the application of radar to the detection of meteor showers; his earlier work on the spectra of incandescent meteors has contributed much to our knowledge of the earth's atmosphere.

The Kimber Genetics Awards, which are being presented for the first time this year, have been established by the Kimber Farms Foundation of Niles, California, to recognize distinguished scientific contributions in the field of genetics, either through single accomplishments of unusual significance or through a long period of significant productivity. Dr. Castle, who is eighty-seven, was one of the first workers in the United States to study mammalian genetics; near the turn of the century his research showed decisively the role of what we now know as genes as the mechanisms by which inherited characteristics are transmitted. Dr. Muller's most important

contributions to genetics have been his studies of the genetic effects of radiations, work which has shed much light on the structure and function of the chromosomes; he was awarded the Nobel Prize for Physiology and Medicine in 1946.

The following new elections were made to the Council of the Academy: *Home Secretary*, Dr. Hugh L. Dryden, director of the National Advisory Committee for Aeronautics, Washington, D.C.; *Members of Council*, Dr. E. A. Doisy (St. Louis University School of Medicine), Dr. Theophilus S. Painter (University of Texas) and Dr. James Gilluly (United States Geological Survey, Denver, Colorado). The other officers of the Academy, who were elected in previous years and will continue until the expiry of their terms of office, are as follows: *President*, Dr. Detlev W. Bronk; *Vice-President*, Dr. George W. Corner; *Foreign Secretary*, Prof. John Gamble Kirkwood; *Treasurer*, Dr. William J. Robbins; *Members of Council*, Prof. Farrington Daniels, Dr. Hugh L. Dryden, Dr. Robert F. Loeb, Prof. Wendell M. Stanley, Dr. Merle A. Tuve and Prof. Edwin B. Wilson.

The following have been elected members of the Academy: W. F. Albright, professor of Semitic languages, Johns Hopkins University; L. R. Blinks, professor of biology, Stanford University, and director of the Hopkins Marine Station, Pacific Grove, Calif.; R. D. Brauer, professor of mathematics, Harvard University; H. S. Brown, professor of geochemistry, California Institute of Technology; R. K. Burns, staff member, Carnegie Institution of Washington; S. Chandrasekhar, professor of theoretical astrophysics, Yerkes Observatory, University of Chicago; J. Chipman, professor of metallurgy, Massachusetts Institute of Technology; C. S. Coon, curator of ethnology, University Museum, University of Pennsylvania; R. Courant, professor of mathematics and director, Institute of Mathematical Science, New York University; G. Dalldorf, director of the Division of Laboratories and Research, New York State Department of Health; P. H. Emmett, senior fellow, Mellon Institute, Pittsburgh; R. W. Gerard, professor of neurophysiology, Neuropsychiatric Institute, University of Illinois; K. Gödel, professor of mathematics, Institute for Advanced Study, Princeton; R. G. Herb, professor of physics, University of Wisconsin; J. Holtfreter, professor of zoology, University of Rochester; M. K. Hubbert, research geologist, Shell Oil Company, Houston, Texas; N. J. Leonard, professor of chemistry, University of Illinois; C. M. MacLeod, professor of microbiology, New York University College of Medicine; H. W. Magoun, professor of anatomy, University of California Medical Center, Los Angeles; D. Montgomery, professor of mathematics, Institute for Advanced Study, Princeton; P. McC. Morse, professor of physics, Massachusetts Institute of Technology; J. R. Pierce, director of electronics research, Bell Telephone Laboratories, Inc.; C. P. Smyth, professor of chemistry, Princeton University; E. E. Snell, professor of chemistry, University of Texas; K. W. Spence, professor of psychology, State University of Iowa; G. E. Uhlenbeck, professor of theoretical physics, University of Michigan; R. C. Williams, professor of biophysics and biophysicist to the Virus Laboratory, University of California,

Berkeley; D. W. Wilson, professor of physiological chemistry, School of Medicine, University of Pennsylvania; P. W. Wilson, professor of bacteriology, University of Wisconsin; and S. Winstein, professor of chemistry, University of California, Los Angeles.

The following have been elected foreign associates of the Academy: Prof. Max Born, formerly professor of physics in the Universities of Göttingen and Edinburgh; Dr. Bertil Lindblad, director of the Stockholm Observatory; Dr. André Lwoff, head of the Department of Microbial Physiology, Institut Pasteur, Paris; and Sir Alexander Todd, professor of chemistry in the University of Cambridge.

TWELFTH GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF BIOLOGICAL SCIENCES

THE International Union of Biological Sciences held its twelfth General Assembly in the rooms of the Consiglio Nazionale delle Ricerche in Rome during April 11–16. The following nineteen countries were represented by delegations: Belgium, Canada, Czechoslovakia, Denmark, Egypt, France, German Federal Republic, Great Britain, India, Israel, Italy, Japan, The Netherlands, Norway, Sweden, Switzerland, Union of South Africa, United States, Yugoslavia.

At the previous General Assembly, held at Nice in August 1953, the Assembly appointed a Policy Board, under the chairmanship of Prof. Paul Weiss, to advise the Bureau on the future scope and structure of the Union. The Policy Board met in Paris during July 1954, and made a series of recommendations which the Bureau laid before the General Assembly at Rome for discussion and subsequent adoption in statutory form.

Here lay the chief task of the twelfth General Assembly, and it was clear that the national delegations had come determined to set the affairs of the Union on a new foundation. Under the inspired chairmanship of Prof. Sven Horstadius, the Assembly did indeed create a new body within the framework of a completely fresh set of statutes. The Union is now organized in three divisions, namely: Botany (Plant Biology); Zoology (Animal Biology); General Biology. Each division is composed of a number of sections, not necessarily corresponding to the sections of the old Union. On the contrary, the statutes now lay down that "No section shall be accepted unless its admission is requested by a recognised International Association in the discipline it professes; or by at least six National Committees which include representation of that discipline". This means that in future each section will be truly representative of the workers in the particular field of biology it claims to cultivate.

In the new administrative structure, the small Bureau of the old Union disappears. There are now only two organs, the General Assembly and the Executive Committee. The Executive Committee consists of the officers of the Union together with two representatives from each division. The following persons were unanimously elected at Rome on the recommendation of a nominations committee appointed by the General Assembly: *President*, Sven Horstadius (Sweden); *Vice-President*, R. E. Cleland (U.S.A.); *Secretary-General*, G. Montalenti (Italy); *Treasurer*, J. Lanjouw (The Netherlands);

Secretary, R. Ulrich (France). Division of Botany: P. Chouard (France), J. Rousseau (Canada); Division of Zoology: E. Handschin (Switzerland), B. Rensch (German Federal Republic); Division of General Biology: A. A. Miles (Great Britain), P. Gaillard (The Netherlands).

The new Executive Committee plans to meet in London in November 1955. London will also be the venue of the next General Assembly in 1958, to be held immediately prior to the Zoological Congress already planned for July of that year.

The General Assembly adopted two important resolutions. The first of these supports the resolution passed by the International Council of Scientific Unions a year ago underlining the potential danger to deep-sea research of the draft articles on the continental shelf framed by the International Law Commission of the United Nations. The second concerns the radiation hazards of large-scale fission and thermonuclear experiments, and the problem of the disposal of atomic waste. The International Union of Biological Sciences urges the immediate need of a special committee of the International Council of Scientific Unions to report on these matters. This second resolution will be considered by the forthcoming General Assembly of the Council at Oslo in August 1955.

Other business carried out by the Assembly included the following items: The admission of Scientific Psychology as a Section in the Division of General Biology, on the request of the competent bodies in Brazil, Belgium, France, Spain, Switzerland, Japan and the United States. Responsibility for the Type Culture Collections is to be delegated to the Executive Committee of the International Association of Microbiologists, with a recommendation that precedence should be given to specialized collections of micro-organisms in allocating subventions drawn from Unesco. A Commission on Photo-Biology in the Division of General Biology was established. It was decided to send an observer to the forthcoming meeting of the Executive Committee of the ICSU Abstracting Board at Zurich in July 1955. Dr. Anton Bruun (Copenhagen) was appointed to the Special Committee of the International Council for the International Geophysical Year 1957–58. Applications from the International Unions of Biochemistry and of Physiological Sciences for admission to the International Council of Scientific Unions are to be supported. The Union also decided to support the movement to increase the annual payments to the International Council of Scientific Unions.

An important symposium on "Topics of International Concern in the Life Sciences" was held during the week of the Assembly.

NEW ENGINEERING BUILDING FOR THE UNIVERSITY OF SHEFFIELD

THE opening of the new Engineering Building for the University of Sheffield on April 27 by the Minister of Defence, Mr. Selwyn Lloyd, marks the realization of long-planned developments in the engineering departments of the University. By 1945 the University's engineering buildings had become inadequate, even for the equipment then installed, and no more students could be accommodated,

though the nation's need for more engineers called for a large expansion both in student numbers and in training facilities. So, under the enthusiastic leadership of Prof. H. W. Swift, the Departments of Engineering were completely replanned to provide for about three times the pre-war number of students and for the equipment that they and an enlarged staff would need for teaching and research.

The new building stands on sloping ground on the north side of the St. George's Square site, and has a volume of nearly one and a half million cubic feet. It has three main floors, which are continuous with corresponding floors of the existing buildings. These are on the site of the old Sheffield Technical School, where the Department of Engineering was already well established so long ago as 1889.

The new building, which was begun in 1950 and is now in full use, houses the whole of the Department of Civil Engineering and most of the Department of Mechanical Engineering which, however, still retains some rooms in the old building. The Department of Electrical Engineering is thus able to expand in the old building, though it also has some rooms in the new building. Accommodation is thus provided in the three engineering departments for an annual intake of about ninety engineering undergraduates and about twenty postgraduate research workers, as well as for courses in engineering subjects for other technologists.

The cost, nearly £500,000, of the extensions has been provided largely from Government sources; but many generous donors have also contributed.

In general, the planning of the new building and the allocation of its rooms have been based on functional considerations. On the bottom or *A* floor are those laboratories requiring heavy equipment, considerable headroom or under-floor services. The sloping nature of the site made it possible to provide considerable headroom in these laboratories, which house large equipment, and also to provide a sub-ground floor containing a basement hydraulics laboratory and the heating boilers, electric substation and other services for the whole of the Applied Science Buildings. On the top or *C* floor are lecture rooms, drawing offices and most of the work-rooms. On the intermediate *B* floor are the laboratories containing light-weight apparatus, a photographic suite, a few work-rooms and a museum which already contains a collection of objects of historic interest to engineers. Private rooms for staff are provided on both *B* and *C* floors and along a mezzanine corridor. Lecture rooms and laboratories have been located on the south side of the building, as far away as possible from street noises.

Two of the five new lecture rooms have been planned to meet the needs of professional bodies and technical societies which hold their meetings in the Applied Science Building. These lecture theatres have capacity for audiences of 200 and 100, respectively, and are provided with complete demonstration services and projection equipment, adjacent ante-room, cloak room and other conveniences.

The system of student work-rooms is a feature of the new building and of the type of curriculum for which it has been planned. In a non-residential university, it is specially important that every student should have a place where he can go for private study at any time, day or evening, when he is not receiving formal instruction, and where he can obtain tutorial assistance or discuss his work with other members of his own group. In the new building

there is a work-room for each group of students, and a work-table and locker for each individual student. A work-room can be used as a drawing office and lecture room for its own particular group.

The photographic needs of all three Departments are met in a suite of small rooms arranged along both sides of a safe-lighted corridor, so that individual students can gain experience in technical photography. The processes available include all the standard types of photographic copying, enlarging, slide preparation, photo-elasticity, record and micro-film reading and projection.

While the new building was being designed and built, extensive new equipment for the laboratories was being purchased, or designed and made in the engineering workshops, so as to meet the future needs of the reorganized departments. Much old equipment has also been improved and adapted to the requirements in the new laboratories. It is impossible to describe fully here the various laboratories and their equipment, though a few points regarding their design and layout may be mentioned.

With a few exceptions, the laboratories have been planned and equipped for both teaching and research, since most of the equipment and services are required for both purposes and since the laboratories are usually required for formal class-work for only a small proportion of the total working hours. Cranes and runways are fitted in most of the major laboratories on *A* floor, and easy access for heavy equipment is provided from an approach road at the back of the building.

Large civil engineering laboratories are provided on *A* floor for hydraulics, concrete technology and structures. Each of these has a floor area of about 3,400 sq. ft. and is 22 ft. high. A feature of the Concrete Technology Laboratory is the provision of two inner rooms in which concrete specimens may be cast and cured under constant atmospheric conditions. In the Hydraulics Laboratory, the machines and flow-systems are arranged so that experiments on them can be carried out simultaneously without mutual interference. Laboratories for Soil Mechanics and Light-weight Structures are provided in the civil engineering section on *B* floor.

The Electrical Engineering Department is being enlarged and reconstructed in the old building, as previously mentioned. In the near future, when these alterations are complete, seven electrical laboratories will provide for experimental work on electrical machines and power utilization, communications and electronics and measurements of standards. Two of these laboratories will be reserved for postgraduate work. Particular attention has been paid to accommodating the maximum number of students in these laboratories, and various novel features have been incorporated to minimize the floor-space required by equipment in order that each student shall have reasonable room to work.

Laboratories in the Mechanical Engineering Department are provided on *A* floor for the study of materials testing, machines and heat engines. On *B* floor there are laboratories for applied heat and metrology, and two rooms of the old building are being reconstructed to provide the first-year Mechanics Laboratory. An essential feature in planning these laboratories has been flexibility in arrangement and equipment. Services, foundations and fixing facilities have been designed to permit easy interchange of plant and apparatus without any interference with the building fabric.

The construction of the Heat Engines Laboratory presented many special problems. The power-units are effectively insulated from the building fabric. Airborne noise is reduced by using sound-absorbing tiles on parts of the walls and a special ceiling finish. All services are taken under the operating floor and connected to the engine beds with vibration-proof flexible connexions.

The new laboratories and their equipment, besides providing greatly enhanced teaching facilities, have much increased the potentialities for research in the three engineering departments.

This article is mainly concerned with the new building; but brief mention of the present undergraduate courses in engineering may be of interest. Since 1948 the degree courses in engineering have occupied three post-intermediate years for all students, and students are only admitted to the courses when they have reached intermediate standard in the essential preliminary subjects. There is no official intermediate course in engineering; but students not already qualified at this level can be admitted to preliminary courses in intermediate subjects. During the first (post-intermediate) year, all engineers follow a common curriculum in mathematics and applied science subjects, and this continues into the second year with some specialization for civil engineers. Honours and ordinary groups are separated in each Department after the examinations at the end of the second year, and the final-year courses are effectively specialized in content as between departments and distinct in type as between honours and ordinary groups in each Department. An essential part of the final course is a project, either an investigation, design or analysis, giving the student opportunity to develop his individual ability and initiative.

FORESTRY RESEARCH IN GREAT BRITAIN

THE report of the Forestry Commission for the year ending March 1953* is divided into two parts, the first detailing work carried out by the Commission's forestry research staff, and the second discussing research undertaken for the Commission by workers attached to universities and other institutions. In the section dealing with seed investigations, it is reported that the first 795 germination tests were undertaken, one-fifth of the tests being carried out by the tetrazolium vital-staining technique. An interesting point about seed storage is that it has been shown that acorns can be stored in moist peat for two years with little loss in viability, and beech mast for eighteen months. Various methods are being tried of improving derelict woodlands, many of them old coppice or coppice with standards, neglected since, with certain exceptions, the coppice is no longer a remunerative crop. In this work, different degrees of intensity of planting are being compared, from complete planting of cleared areas, to enrichment of existing regrowth using single large plants. On suitable sites the use of conifers in mixture with hardwoods to give earlier returns is being tried.

Under forest entomology, surveys of sawflies in spruce and larch crops were continued from previous

seasons. It is becoming evident that foresters in Britain will have to deal with a different lot or type of forest insect pests as compared with the better-known ones so long studied on the Continent of Western Europe. Notable work has been undertaken in Great Britain since the introduction of machinery. Forest conditions are very different from Continental ones, especially in the prevalence of wet ground (even in a dry season on soft forest soils); ploughing work, fire protection and so forth are different. These troubles have led to considerable research and improvement in forest machinery of different types.

Part 2 of the report deals with research work in universities and institutions (such as Rothamsted, for example). Financial assistance is usually given from the Forestry Fund, and some help is provided in carrying out field-work by the Commission's research staff. The work detailed in the report is mainly in connexion with investigations into forest soils.

Large-scale planting of trees on peat is a comparatively recent thing in British forestry, and Bulletin No. 22 of the Forestry Commission deals with "Experiments in Tree Planting on Peat"*. Though during the past century private landowners made numerous attempts to establish plantations on peat land, failures were numerous on the more difficult types of peat, namely, the deeper ones. At this period successful plantations had been established in Russia on peat up to 10-12 ft. in depth. The procedure was to dig drains 3 ft. deep, two or three years later to deepen the drains another 3 ft., and then repeat the operation as necessary after another similar period. Scots pine or spruce seed would then be sown in small pockets, often with some birch, on the top layer of the dried peat. In those days they had plenty of time and unlimited land to choose from; but fifty-year old plantations showed fine development. In Britain and during the present century, more species have been available, such as sitka spruce, Japanese larch, and *Pinus contorta*. Perhaps it is not surprising that the private landowner in Britain, quite untrained in forestry, was unacquainted with the early work in peat-planting on turves being undertaken by the Belgians. It was not until 1907 that Sir John Stirling Maxwell first adopted the method at Curroun in Inverness-shire, and this laid the foundation for most of the subsequent successful developments in the afforestation of peat. The Belgian method did not entirely fulfil all requirements, and it was not until 1926-27 that 'mound' planting (as it was then called) in peat, sitka being one of the chief species used, was done; then the Commission brought into use, to save the high cost of turf digging, the plough, and the Commission developed this technique in an amazing fashion to tackle any utilizable depth of peat. It had been realized before the Second World War, in which little work of this type could be done, that periodical cleaning and deepening of the drains on peat types are essential to the good growth of the crop.

Paper No. 31 of the Imperial Forestry Institute, University of Oxford, by Dr. L. Leyton, deals with "The Growth and Nutrition of Spruce and Pine in Heathland Plantations"†. Experiments begun in

* Forestry Commission. Bulletin No. 22: Experiments in Tree Planting on Peat. By J. W. L. Zehetmayr. Pp. iv+110+16 plates. (London: H.M.S.O., 1954.) 10s. net.

† Imperial Forestry Institute, University of Oxford. Institute Paper No. 31: The Growth and Nutrition of Spruce and Pine in Heathland Plantations. By L. Leyton. Pp. 109+7 plates. (Oxford: Imperial Forestry Institute, 1954.) 12s. 6d.

* Forestry Commission. Report on Forest Research for the Year ending March 1953. Pp. vi+122+9 plates. (London: H.M.S.O., 1954.) 6s. net.

1949 on the growth of sitka spruce and Corsican pine (Wykeham, Allerston Forest, Yorkshire) and of the sitka spruce and Scots pine (Clashindarroch, Aberdeenshire) have now been completed and certain conclusions have been drawn. The most important limiting factor affecting the growth of spruce in the Yorkshire plantations is a deficiency in the available nitrogen. An increase in the growth of the trees can be obtained, at least temporarily, by removing the heather vegetation around the trees (screefing). Other more expensive measures may be undertaken. In the absence of the heather, when nitrogen is no longer deficient, calcium tends to become a limiting factor. In the Clashindarroch plantation, nitrogen and calcium are both deficient; but manganese may also play an important part, since screefing and heather mulching employed to stimulate growth may also lead to an increase in the manganese concentration in the needles. Both Scots and Corsican pines appear to be less affected than spruce by mineral nutrient deficiencies in the heathland soils, though in the latter case the removal of the heather also effects an improvement in the nitrogen status of the trees in their stimulation to growth. As may be expected, the removal of the ground vegetation during periods of dry weather may lead to excessive desiccation of the upper layers of the soil and thus affect the shallow-rooted spruce, a difficulty well known to foresters who undertake such work in tropical countries with shallow-rooted species.

E. P. STEBBING

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR 1954-55

THE report of the director of research of the Wool Industries Research Association, Dr. A. B. D. Cassie, for 1954-55* refers to the development of ion-exchange methods of analysing liquids which contain soap, fatty acid and wool grease and its extension to the analysis of solutions with anionic, cationic and non-ionic detergents and wool grease; in particular, emulsions of 'Lissapol N' with soap and grease can be separated quantitatively. The glass-type of apparatus for the rapid extraction of soap and grease from wool has now been superseded by an all-metal type. The automatic controller for the woollen card has now proved successful in a number of mills; this is part of a general programme on carding to determine how far a card may be simplified without reducing the quality of its product. The main obstacle to reduction of the number of cylinders on a card appears to be the removal of neps. Results with the pilot worsted drawing and spinning plant have emphasized so much the importance of machine settings that work is now proceeding on methods to determine the optimum settings for any lot of wool.

Much work has been carried out on the best regain and relative humidities for drawing and spinning wool, as well as on the weaving process and on the effects caused by the tension variations that can arise as yarn is pulled from cops or pirns as in the loom shuttle. Work on mothproofing has indicated the conditions of application that lead to

adequate absorption of the moth-proofing agent by the wool and has also shown that application at lower temperatures gives lower resistance to washing. Further studies have been made of the continuous scouring of worsted yarn with synthetic detergents and soap, and of the effect of dyeing processes on the properties of wool, including the use of liquor containing ammonium salts. In the Scottish Laboratory a major cause of the variation in length of yarn wound on per draw of mule has been identified and eliminated. In biology, radioactive materials show considerable promise for examining the processes in the follicles that lead to the formation of fibres. The amino-acid composition of a homogeneous sample of Australian Merino 64's quality wool has been determined, as well as the lanthionine contents of wools which had received alkali treatment, and a new method for cystine analysis has been devised. Work on the generation and dissipation of static electricity is now being applied to separate static and adhesion forces so far as fibre pick-up on rollers is concerned.

At the thirty-sixth annual general meeting of the Association on March 29, when Dr. Cassie's report was presented, the chairman, Mr. J. F. Beaver, referred also to the close liaison maintained with the Work Study Centre of the Wool and Allied Textile Employers' Council in the detailed investigation of the relative merits of the automatic and non-automatic looms. Mr. Beaver also stressed the continued development of the Association's educational activities, particularly in regard to the dissemination of information about the research work of the Association. He remarked on the support given to the Morley Careers Exhibition, held during February 2-9 last, with the object of assisting recruitment of laboratory assistants and also of demonstrating the industry's interest in research. In addition, he referred to the International Conference on Wool Research to be held in Australia this summer at the invitation of the Commonwealth Scientific and Industrial Research Organization (see *Nature*, April 16, p. 667), at which the Association will be represented.

UNIVERSITY COLLEGE, LONDON

ANNUAL REPORT FOR 1953-54

IN the annual report of University College, London, for 1953-54, the chairman of the College Committee, Lord Cohen, and the Provost discuss the progress of the College during the present quinquennium.

In the early years of the quinquennium, departments had to reduce their requirements for new equipment to a degree that threatened in some instances the proper progress of their advanced work and research; the situation has now been so restored that, in spite of stringency, it has been possible to undertake a useful programme for the supply of capital equipment. Further, the institution of a modest number of new posts has been possible and some long-awaited developments have been realized. Thus, while the session has still been one of consolidation, it has also been one of encouraging progress.

This was made possible largely by the increase made through the Court of the University in the grant from the University Grants Committee and the Home Counties. In 1952-53 this had amounted to

* Wool Industries Research Association. - Report of the Director of research for 1954-55. (W.I.R.A. Publication No. 201.) Pp. 81. From the Association, Leeds, 1955.)

£815,000 and was increased in 1953-54 to £862,000. Details are given of the support which the College has received from the great foundations, research councils, and from industrial organizations for various research activities.

The Faculty of Arts commemorated two events which registered its contacts with humanistic studies over the past century. In April 1954 the Classical Association celebrated its jubilee meeting in the College. The other event has a national, or possibly an international, importance that extends beyond its reference to the Faculty of Arts. On September 22, 1954, the restored Mocatta Library and the Gustave Tuck Theatre were opened in the presence of a large gathering of members of the College and of the Jewish Historical Society.

In the Faculty of Science the most valued development was the occupation of the new block of the Department of Physics. A special honours degree in biochemistry has been instituted, the College being the only school of the University to offer courses for such a degree. The total number of students at the College has increased from 3,441 in 1952-53 to 3,551 in 1953-54. The College has in all 743 postgraduate and research students and it has developed its tradition for making special provisions for this ever-increasing though widely scattered part of the College community.

The general impression made by the session has been that the post-war period under which the College suffered so severely is drawing to an end. This is encouraging since some departments are still inadequately housed and others are in urgent need of development.

GROWTH OF MUSCLE FIBRE IN THE FÆTAL SHEEP

By D. M. JOUBERT

School of Agriculture, Cambridge

GROWTH of muscular tissue is generally accepted as occurring by hyperplasia during the embryonic and early fetal stages, and essentially by the hypertrophy of existing fibres in late pre-natal and throughout post-natal life. With regard to the latter aspect of the problem, Schäfer¹ estimated the enlargement of the muscle fibre from mid-fœtal life until birth to be 200 per cent and, in some instances, 300-400 per cent, compared with a five-fold increase from birth to adult life. However, in their recent review of the subject, Adams, Denny-Brown and Pearson² state that previous attempts to measure cross-sectional diameter of muscle fibres at different stages of fœtal life have not yielded uniform results. It would appear that the most detailed investigation to date is that of Cuajunco³, who measured formalin-fixed fibres of human specimens. His measurements showed a gradual change from 9 to 16 μ for the largest, and from 5 to 7 μ for the smallest fibres from the tenth week to full-term.

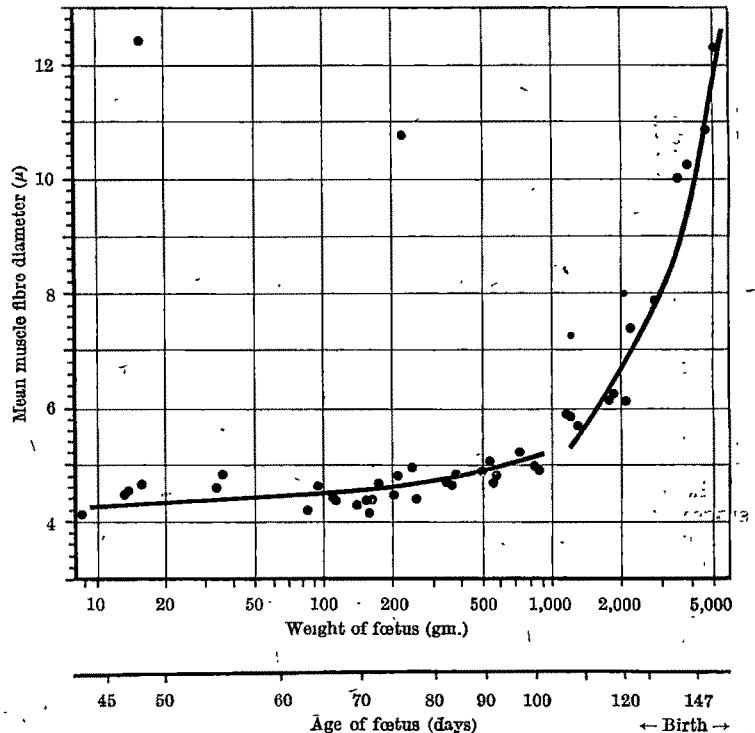


Fig. 1

During the course of investigations on pre-natal growth of the ovine fœtus, the cross-diameters of formalin-fixed muscle fibres were measured by means of an ocular micrometer at a magnification of $\times 420$. Of each of forty-one specimens, ranging in age from 43 days to birth, 150 fibres were measured; fifty per muscle for the *M. longissimus dorsi*, *M. rectus femoris* and *M. gastrocnemius lateralis*. The mean values arrived at for the individuals studied, plotted against fœtal weight, are shown in Fig. 1. Though a time-scale is provided, weight has been chosen as the criterion of muscle-fibre development since the latter variate is more closely correlated with body-weight than with chronological age⁴.

The results indicate that the fœtal muscle fibre undergoes but little change in diameter from a weight of approximately 8 gm. to just over 800 gm., or in terms of age, from about forty-three days to roughly ninety-nine days. During that period as a whole, the fibre measured 4.61 μ on an average, the means for individual fœtuses ranging between 4.17 and 5.23 μ . However, during subsequent stages of development until birth, a considerable increase in fibre diameter is evident, closely corresponding to the increase in body-weight.

For the purpose of clarifying the trend, linear regressions have been calculated separately for the two apparent segments of the curve. The regression lines fitted to the experimental results, as shown in Fig. 1, are based on the following equations:

$$\text{Segment 1: } Y = 4.319 + 0.001065 X$$

$$\text{Segment 2: } Y = 3.533 + 0.001625 X$$

where Y represents muscle-fibre diameter in μ , and X represents weight of fœtus in gm. Theoretically, therefore, the fibre increases in diameter by only 19.5 per cent from a fœtal weight of 8 gm. (4.328 μ) to a weight of 800 gm. (5.171 μ); but from a weight

Table 1. PERCENTAGE FREQUENCY DISTRIBUTION OF MUSCLE FIBRE DIAMETERS OF DIFFERENT WEIGHT GROUPS

Fibre diam. (μ)	Range of weights, within groups (in gm.)								
	12.6-25	26-50	51-100	101-200	201-400	401-800	801-1,600	1,601-3,200	3,201-6,400
n*	450	300	300	1,050	1,050	750	750	750	600
1.6	—	—	0.67	2.94	—	—	—	—	—
3.2	34.0	28.0	31.3	41.3	27.1	21.3	11.8	4.80	—
4.8	45.3	41.3	56.7	39.2	51.0	48.3	44.0	23.2	1.00
6.4	20.7	30.7	11.3	15.2	21.7	29.3	37.5	41.6	11.0
8.0	—	—	—	1.33	0.20	1.06	5.33	14.2	13.0
9.6	—	—	—	—	—	—	1.33	14.9	26.0
11.2	—	—	—	—	—	—	—	0.53	13.3
12.8	—	—	—	—	—	—	—	0.80	22.0
14.4	—	—	—	—	—	—	—	—	2.69
16.0	—	—	—	—	—	—	—	—	8.33
17.6	—	—	—	—	—	—	—	—	0.33
19.2	—	—	—	—	—	—	—	—	2.00
20.8	—	—	—	—	—	—	—	—	—
22.4	—	—	—	—	—	—	—	—	0.33
Group mean	4.56	4.70	4.40	4.39	4.66	4.90	5.45	6.71	10.80

* Number of observations per group

of 1,200 gm. to 5,000 gm. at full-term, the fibre increases by 113.2 per cent, from 5.483 to 11.658 μ .

The range in muscle-fibre diameter at different stages of foetal development is set out in Table 1, measurements on one foetus, weighing less than 12.6 gm., having been omitted. Since the various weight-groups include unequal numbers of observations, the distributions are shown as percentages of their respective totals.

It is evident that the range is limited during the earliest stages; clearer definition of the exact range occurring was not achieved since measurements could be made to the nearest 1.6 μ only. The first noticeable change is shown by the measurements for the group 51-100 gm., however, rather contrary to expectation. Here a proportion of smaller fibres, though only a fraction of the total, appear which reduces the group mean rather abruptly. The proportion of small fibres actually increases in the group weighing between 101 and 200 gm., following which stage they were no longer recorded. A substantial increase in the range occurs only in the groups of higher weight, particularly those of weights 801-1,600 gm. and 1,601-3,200 gm., much as would be anticipated in view of the results shown in Fig. 1. The widest range occurs at birth; but this group also includes the largest range in terms of absolute weight of the specimens.

The results obtained appear to support accepted theory on muscular growth prior to birth. While a differential growth-rate of the fibres, in terms of cross-diameter, is evident, further investigation⁴ showed that the weight of the muscles sampled increased at a very nearly constant rate over the same period. However, despite the rather noticeable break in the curve illustrating age changes in cross-diameter of the fibres between, roughly, 800 and 1,200 gm., it is not inferred that cell formation ceases abruptly at approximately that stage. This aspect of the problem apparently remains to be settled, for, while both MacCallum⁵ and Cuajunco failed to observe evidence of recent division or incomplete separation of fibres beyond mid-foetal life, Tello⁶ identified new fibres in the full-term human foetus.

The occurrence of a proportion of small fibres in foetuses between the weights 51 gm. and 200 gm. agrees with Cuajunco's report on the subject. They were, however, rather less numerous than one would gather from the latter author's observations, and were last recorded in a 69-day-old specimen; Cuajunco reported small fibres up to the twenty-fourth week in the human foetus.

The observations recorded in Table 1 indicate a range in muscle-fibre size from 4.8 to 22.4 μ at birth. According to Tello⁷, the largest of parent fibres remain larger and more fully developed than the daughter fibres throughout foetal life, and can still be recognized by their size and distribution in early infancy. These latter fibres are described by Adams *et al.* as the 'B Fibres' of Wohlfart. The present results, however, provide but limited evidence on the presence of two types of fibres, so distinctly different in diameter that it should be shown by the shape of the distribution curve at birth. Though two modes are present, the first at 9.6 μ and the second at 12.8 μ , the difference is not as large as one would expect in view of the foregoing description of the fibre types. Indeed, the shape of the distribution curve obtained is obviously influenced by the fact that newly-born lambs are included ranging in weight from 3,591 to 5,248 gm.

Detailed results of the investigation will be published elsewhere.

Acknowledgments are due to Messrs. I. Gordon, R. W. L. Averill and Dr. G. L. Hunter, School of Agriculture, and to Mr. G. Pluck, Animal Research Station, Cambridge, for their valuable assistance with the collection of material. To Dr. John Hammond I am grateful for providing facilities and for his advice and encouragement. [March 18

¹ Schäfer, E. A., "Textbook of Microscopic Anatomy" (Longmans, Green, London, 1912).

² Adams, R. D., Denny-Brown, D., and Pearson, C. M., "Diseases of Muscle" (Cassell, London, 1953).

³ Cuajunco, F., Contr. Emtry. Carn. Inst., 30, No. 195, 127 (1942).

⁴ Joubert, D. M., *J. Agric. Sci.* (in the press).

⁵ MacCallum, J. B., *Johns Hopkins Hosp. Bull.*, 9, 208 (1898).

⁶ Tello, J. F., *Trab. Lab. Invest. Biol. Univ. Madrid*, 15, 101 (1917).

⁷ Tello, J. F., *Z. Anat. Entw. Gesch.*, 64, 348 (1922).

TIDAL GRAVITY MEASUREMENTS IN THE SHETLANDS

EFFECT OF THE TOTAL ECLIPSE OF
JUNE 30, 1954

By PROF. R. TOMASCHEK

Research Centre, The British Petroleum Co., Ltd.,
Kirkcubbin Hall, Notts

THE application of tidal gravity measurements to geophysical and geological problems has been discussed in a previous communication. The first results of an extended investigation into the tidal variation at Unst (Shetlands), including measurements in the zone of totality during the eclipse of

June 30, 1954, will be described here. Observations at these high latitudes are of special interest for two main reasons. First, they extend our knowledge of the dynamic elastic deformation of the earth's sphere into a region not yet properly investigated. Secondly, in this region the variations of the vertical component of gravity are predominantly diurnal and offer, due to the small range of daily temperature variations and the length of the observation period, an additional opportunity of determining the diurnal elastic deformation which, in contradistinction to the semi-diurnal variations, may be influenced by the liquid core of the earth². Another point of interest is that new information on the oscillations of tectonic blocs can be expected, as the Shetlands belong to the same general tectonic structure as the northern part of the British Isles, and meteorological events in the Atlantic should influence the Shetlands in a similar way. Furthermore, the unique opportunity of observing in the zone of totality of an eclipse makes it possible to obtain more exact experimental information on the problem of a possible variation of gravitation by interposing a third body between two attracting masses³.

Three gravimeters were used simultaneously: two Frost gravimeters (No. 32 and No. 54) the properties of which have been described previously⁴, equipped respectively with one and two thermostats, and a normal Worden gravimeter (No. 189) in an additional thermo-insulating container. The Frost gravimeters were at Baltasound (lat. 60° 45' 45" N.; long. 0° 51' 10" W.) and the Worden instrument at Skaw (lat. 60° 49' 08" N.; long. 0° 47' 30" W.). The Frost gravimeters were normally read half-hourly by ocular observation, and a continuous set of observations for both gravimeters during June 12–July 15, 1954, was obtained. The readings of the Worden instrument were registered photographically. Due to difficulties with the camera, uninterrupted half-hourly records were only obtained during June 29–July 15. During June 29–July 1, the readings of the Frost gravimeters were practically continuous shortly before, after and during the hours corresponding to the eclipse, and the frequency of photographic exposures was increased to 5- and even 2-minute intervals for the Worden meter.

The most reliable results were obtained with Frost 54, as the good fit with the theoretical tidal curves showed at once, and as was expected from previous experience with it. The other Frost meter, No. 32, shows a strong influence of pressure and a phase lag against the pressure variations. The pressure correction is therefore particularly difficult for this instrument, because of the large amplitude and high

frequency of the barometric variations in this region of high latitude. The Worden gravimeter, which in these experiments was used for the first time for continuous tidal measurements, shows a strong elastic drift and is also affected by outer temperature variations the influence of which can be assessed exactly only with difficulty. Its damping is also less effective, so that it is influenced to a certain degree by microseisms. The results obtained with Frost 32 and Worden 189 have therefore a greater margin of mean deviation.

The results of the harmonic analysis are shown in Table 1 for Frost 54, using the Admiralty method.⁵

From these results the mean value of G_0 for semi-diurnal tides is 1.20; for diurnal tides 1.09. The overall geocentric mean, weighted according to the respective amplitudes, is $G_0 = 1.13$. The accuracy of the value is mainly determined by the accuracy of the calibration factor and by the influence of systematic pressure variations. According to former experience, it may be assumed to be ± 3 per cent in the present investigations.

The factor G for semidiurnal tides is in good general agreement with that found in lower latitudes, but lies on the high side, if compared with 1.10 ± 0.04 for the semidiurnal tides M_2 and S_2 at Peebles (Scotland), which were measured with the same instrument. The phase shift of 15° for M_2 in the Shetlands is rather large and indicates the influence of oceanic tides. A definite answer regarding the significance of the difference can therefore be given only after discussion of these maritime influences.

The diurnal elastic yielding is definitely lower than the semidiurnal. Their ratio is not influenced by uncertainty due to the calibration factor, which is about ± 0.7 per cent. As at Unst, the amplitude of the diurnal tides is more than double that of the semidiurnal tides, and the observational period is one month; this difference seems to be significant and should contribute towards obtaining quantitative data for assessing the influence of the liquid core. A discussion of the problems raised by the harmonic analysis data will be given in a comprehensive paper elsewhere.

The general drift of Frost 54 determined according to the Admiralty method shows no correlation with the barometric curve, proving the correctness of the pressure correction, but shows a correlation with the general pressure changes over the North Atlantic. This indicates movements of the tectonic bloc induced by these changes similar to those already observed in the British Isles⁶.

A unique opportunity was given by the total eclipse of the sun on June 30 of studying the influence

Table 1

Component	H	M_2	κ	H	S_2	κ	H	K_1	κ	H	O_1	κ
H Theoretical	17.80	—	—	8.29	—	—	37.15	—	—	26.50	—	—
Set I	21.71	+ 14.2°	—	10.06	— 4.8°	—	41.60	— 5.4°	—	28.22	+ 3.6°	—
Set II	21.55	+ 14.9°	—	10.02	— 4.6°	—	41.46	— 5.8°	—	28.57	+ 2.6°	—
Vectorial mean	21.64	+ 14.6°	—	10.04	— 4.7°	—	41.54	— 5.6°	—	28.40	+ 3.1°	—
$G = H_{obs}/H_{theor}$	1.22	—	—	1.21	—	—	1.12	—	—	1.07	—	—
G_0	1.20	—	—	1.20	—	—	1.11	—	—	1.06	—	—

M_2 ($T = 12.42$ h.) main lunar and S_2 ($T = 12.00$ h.) main solar semidiurnal constituents.

K_1 ($T = 23.93$ h.) lunisolar and O_1 ($T = 25.82$ h.) main lunar diurnal constituents.

The amplitude of vertical component of gravity H is in thousandth of milligals. κ = phase difference against theoretical phase; G = gravimetric factor for geographical latitude; G_0 = gravimetric factor for geocentric latitude = H_{obs}/H_{theor} .

Set I comprises the values for integral hours, Set II those for the half-hours.

on gravity due to the interposition of the moon between the sun and the earth⁷. Although the centre of totality ran nearly forty miles to the north, the observational points were well in the zone of totality, and the duration of totality was about 86 sec.

In order to investigate the effect, it was necessary to compare the measurements of gravity during the time of the eclipse with the statistical oscillations of the measurements on adjacent normal days.

The method of reducing the observations of Frost 54 is as follows. After correction for pressure, the general drift was removed using the Admiralty method. As the elastic yielding of the earth is known from the harmonic analysis (Table 1), the tidal effect has been subtracted from the corrected observations of June 29 and 30 and July 1. It showed that, within the relevant time interval of 10h. 30m.-14h. G.M.T., the curves of the residuals on all three days were very nearly linear. In order not to introduce any bias, therefore, a linear drift correction was applied to the residuals. The result is shown in Fig. 1. It shows the statistical oscillations (including slight systematic deviations from linearity) of the residuals of normal days in the bottom and top graph, compared with those during the eclipse. All three graphs are well within the limits of ± 10 thousandths of a milligal. The standard deviation of the residuals on eclipse day is 2.7 thousandths of a milligal.

The results from the two other gravimeters were treated in a similar way, but the direct observed values without pressure correction have been used. Furthermore, the curves for the eclipse day had to be smoothed by double averaging for both gravimeters to make them comparable with the adjacent days, as Frost 32 was oscillating due to strong microbarometric variations, and Worden 189 due to the microseisms of the island on eclipse day. The

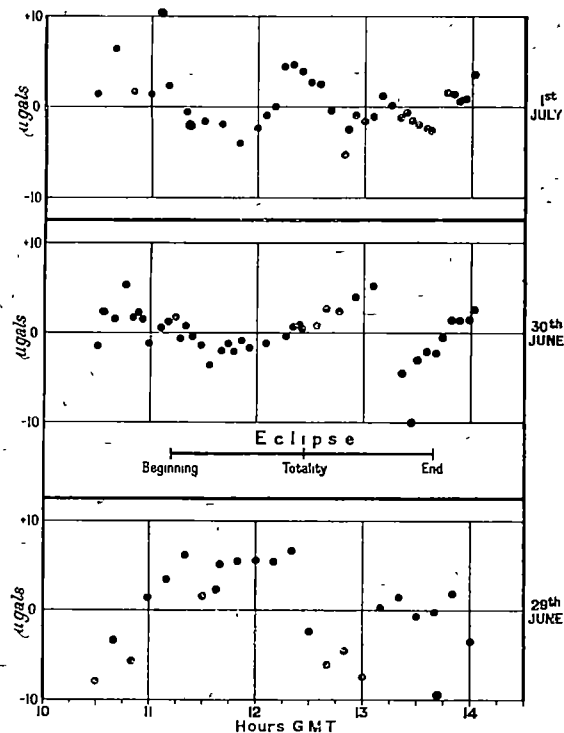


Fig. 1. Gravitational residuals of gravimeter Frost 54. Deviations from mean gravity corrected for tide elasticity and drift.

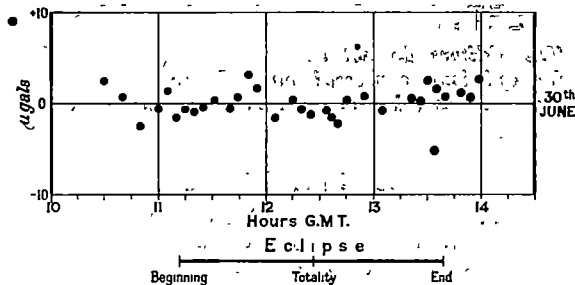


Fig. 2. Mean of gravitational residuals of all three gravimeters on eclipse day.

standard deviations on eclipse day were 3.6 and 3.7 thousandths of a milligal respectively.

Fig. 2 shows the mean for all simultaneous observations of the three instruments during the eclipse, giving each gravimeter set the same weight. As the times of reading sometimes differed slightly, the range for coincidence for averaging was taken as 3 min. at the most. The standard deviation of these means is 1.4 thousandths of a milligal.

The statistical discussion of the combined observations, which will be given in a comprehensive paper elsewhere, leads to the following conclusions:

(1) No significant systematic effect was observable during the eclipse.

(2) The consequence of an absorption or attenuation of the gravitational field of the sun would be an apparent increase of gravity for the observer. The chances of detecting a systematic effect of this kind would have been more than 100:1 for an effect showing a maximum of 3 thousandths of a milligal at totality. This means that a systematic absorption effect equivalent at its maximum to three parts in one thousand millionths of the earth's gravitational field would have been certainly observed. The vertical component of the sun's gravitational field is calculated to have been 470 milligals, so that the interposition of the moon between the earth and the sun could certainly not have altered the intensity of the field due to the sun by more than one part in a hundred thousand.

(3) Regarding the possibility of an absorption effect of matter on gravity, 3 thousandths of a milligal correspond, applying Majorana's⁸ theory, to an upper limit for an absorption coefficient of gravity α of less than 10^{-14} , that is, about a thousand times less than the value deduced by Majorana from his experiments.

I wish to thank all who helped in this investigation, especially the members of the expedition, H. T. Rochelle, A. N. J. Eales, C. E. Saul and R. Brown, and Mr. and Miss Saxby, of Hallgarth, for their hospitality on Unst. Acknowledgment is also made to the Chairman of the British Petroleum Co., Ltd., with whose permission this communication is published.

⁷ Tomaschek, R., *Nature*, 173, 143 (1954).

⁸ Jeffreys, Sir Harold, *Mon. Not. Roy. Astro. Soc.*, 109, No. 6, 670 (1949).

⁹ Tomaschek, R., *Naturwiss.*, 26, No. 12, 185 (1937).

¹⁰ Tarrant, L. H., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, 278 (1952).

¹¹ Tomaschek, R., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, No. 5, 286 (1952).

¹² See *Observatory*, 72, No. 866, 16 (1952), and Tomaschek, R., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, No. 9, 540 (1954).

¹³ See also Sandig, H. U., *Vermessungen*, No. 12, 406 (1954).

¹⁴ Majorana, G., *Phil. Mag.*, (6), 39, 488 (1920); *C.R. Acad. Sci., Paris*, 173, 478 (1921). See also Russell, H. N., *Astrophys. J.*, 54, 394 (1921).

LETTERS TO THE EDITORS •

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Sleep in Ruminants

DURING digestion experiments with cattle, it was observed that the animals never appeared to sleep and always used the same lying position. In recent years the behaviour of cattle and sheep has been carefully studied by numerous workers, particularly under grazing conditions; the subject has been reviewed by Tribe¹ and Hancock². In spite of this attention, the almost complete absence of reference to sleep is a striking feature of the reports. Brownlee³ could find no evidence that healthy cattle ever lost consciousness either by day or night. Similarly, Hancock⁴ found that it was debatable if cows ever sleep; even at times of total rest they kept their eyes open except for very short periods—a few minutes at most—when they generally rested their heads on the flanks.

It is difficult to find an exact definition of sleep acceptable by all authorities; in the present work a search has been made for the marked relaxation and loss of consciousness (especially of vision) which are the more obvious manifestations of sleep in other animals. In the vast majority of cattle seen at night, the eyes were open and clearly watching the observer. In the few instances where they were closed the movement of an ear would often betray consciousness, or slight noises such as rubbing together of the fingers would evoke an immediate reaction.

In order to confirm that the absence of mention of sleep from published reports did in fact mean that none was observed, I have communicated with a number of the observers. Their replies were in close agreement with observations here, namely, that sheep and cattle sleep little if at all, rarely closing their eyes and seeming even then not to lose consciousness. When lying, they keep the thorax upright and only very rarely and for short periods lie out flat. Observation and inquiry in zoos has confirmed that the apparent lack of sleep and the typical lying position are general characteristics of ruminants.

Following the classical studies of Schalk and Amadon⁵ on the mechanical process of the reticulo-rumen, it has become increasingly clear that the arrangement of the large amount of digesta in the reticulo-rumen is partly dependent on gravity. Tilting the organ either laterally or in a dorso-ventral plane must lead to displacement of the fluid materials found in the reticulum and ventral rumen and of the gas bubble normally present in the dorsal sac of the rumen. This leads to dysfunction of the reticulo-rumen⁶. The twist and curve given to the body by the sideways position of the pelvic girdle in lying ruminants other than camels will not interfere with the arrangement in the anterior (cran-

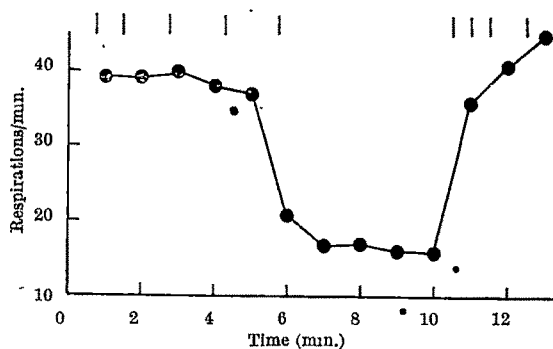


Fig. 1. Fall in respiration-rate in one of the periods of slow breathing. This occurred at 0320 hr., while the cow was lying resting. The short vertical strokes indicate contractions of the reticulum

ial) rumen and reticulum. The role of gravity in the proper functioning of the reticulo-rumen is clearly the reason for the upright position of the thorax during lying. Young calves appear to sleep and sometimes lie flat on their sides (private communication from J. H. B. Roy and K. W. G. Shillam), and very fat beef cattle sometimes roll over, because of their inability to maintain the normal lying position, and may also sleep. It appears, therefore, that the apparent absence of sleep and the specialized lying position are, as would be expected, found only in normal adult ruminants in which the reticulo-rumen is fully functional. Steinhart⁷ has shown that sleep is normal in the horse, an animal which in the wild state has the same environment as several species of ruminants. Stabled horses in Germany slept on average seven hours out of the twenty-four, and Steinhart was able to gauge the depth of sleep by the time required for reaction to the stimulus of offered food. The lightest form of sleep (reaction in less than 2 sec.) was sometimes observed in standing horses; but deep sleep was only observed in horses lying out flat. In these latter instances the reaction time exceeded 6 sec. and there was usually no reaction. In extensive nocturnal observation of ruminants, I have yet to find an individual which would not have reacted to the presence of the observer before Steinhart's test could have been applied.

A modified kymograph giving an ink tracing on paper charts has been used for recording pressure changes in the reticulum of fistulated cows during periods of many days duration. The records show respiration-rate, reticulo-ruminal motility and whether the animal is standing or lying and ruminating or resting. They have been supplemented by frequent observa-

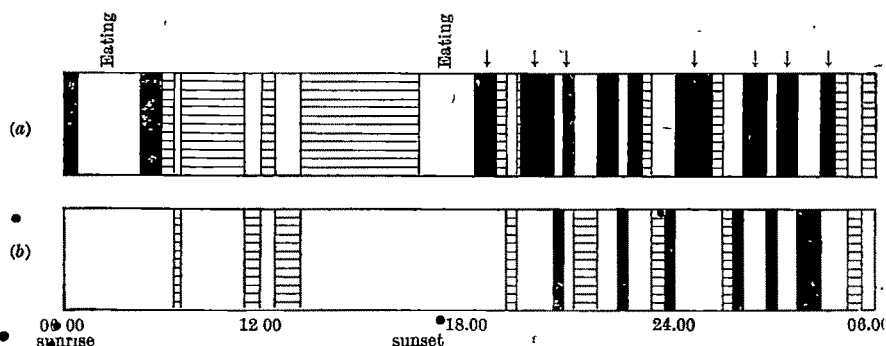


Fig. 2. Periods of (a) eating and resting and (b) ruminating, while standing (shaded areas) and resting (black areas). Typical values for a cow kept in a cowshed. In the periods of lying resting indicated by arrows, there were ten periods of slow breathing totalling 31 min.

tion at night. During the night there is little general slowing of either reticulo-ruminal activity or respiration-rate while the animal is lying resting, lying ruminating or standing ruminating.

Deep regular breathing at a slow rate is frequently, but not invariably, found in sleeping animals. The kymograph records were accordingly searched for such breathing and a small number of periods were found. These could be detected in spite of the dependence of normal respiration-rate on temperature; on days when the temperature averaged about 50° F. the mean respiration-rate was 19–25/min., whereas at 65° F. it was 45–49/min. in the same two cows. The periods of slow breathing (Fig. 1) were most easily observed at the higher temperatures. Their duration varied from 1 to 10 min., with an average length of less than five minutes, and they frequently ended suddenly. This slow deep breathing was seen only while the cows were lying at night and resting, and the longest total observed in any one night was 36 min. During these periods there was usually a marked slowing of the rate of contraction of the reticulum (Fig. 1). Subsequent recording at the lower temperature disclosed a few periods of slow breathing, also while the animal was lying resting. Because of the slower general rate of respiration, these were less distinct than the periods observed earlier, but were again accompanied by a lowered rate of contraction of the reticulum. Observation of the cows during several periods of slow deep breathing disclosed no loss of consciousness; the periods do, however, appear to represent the maximum relaxation achieved by cattle and the closest approximation to sleep, and it is probably then that the eyes are sometimes closed. The periods were found only when the animal was lying resting and never during rumination.

Rumination occupies a series of periods, usually of less than an hour in length, throughout the twenty-four hours (Fig. 2). The amount of time spent ruminating varies with such factors as the fibrous properties of the diet and the availability of grazing; it frequently totals nine hours out of the twenty-four and, especially in grazing animals, is somewhat concentrated into the hours of darkness. There seems to be no possibility that sleep occurs during rumination, because, in addition to the disturbing effect of the constant chewing and regurgitation, the maintenance of the head in the unsupported position invariably found during rumination would appear to demand a considerable degree of consciousness, to preclude the "immobility of the body" and to demand the function of that "sum total of tonic reflexes of proprioceptive, labyrinthine and visual origin that are responsible for righting the body and maintaining the normal position" and which is usually inoperative during sleep⁸. This may even be necessary, to a lesser extent, for the maintenance of the characteristic lying position of ruminants, especially when the head is not resting on the legs or on the ground.

Since during the night the periods of lying resting are interspersed with periods of standing and of rumination (Fig. 2), it follows that if sleep occurs at all in cattle it must be of the polyphasic type.

It is concluded, therefore, that under normal conditions of management healthy adult cattle and sheep, and probably ruminants in general, sleep little, if at all. If sleep does occur, it can only be of a very light and transient nature. This peculiarity of ruminants may be related to the need for maintaining the thorax in an upright position for proper functioning of the reticulo-rumen, and to the requirement of

time and consciousness for rumination. The implications of this observation are being investigated.

My thanks are due to all those who have communicated privately with me on this matter. I wish also to thank members of the staff of the London and Bronx Zoos, who kindly answered my inquiries and aided my visits.

C. C. BALCH

National Institute for Research in Dairying,
University of Reading. Jan. 28.

¹ Tribe, D. E., *J. Brit. Grassland Soc.*, 5, 209 (1950).

² Hancock, J. L., *Anim. Breeding Abstr.*, 21, 1 (1953).

³ Brownlee, A., *Bull. Anim. Behav.*, No. 8, 11 (1950).

⁴ Hancock, J. L., *Emp. J. Exp. Agric.*, 18, 249 (1950).

⁵ Schalk, A. F., and Amadon, R. S., *Bull. N. Dak. Agric. Exp. Sta. No. 216* (1928).

⁶ Cole, H. H., Huffman, C. F., Kleiber, M., Olsen, T. M., and Schalk, A. F., *J. Anim. Sci.*, 4, 183 (1954).

⁷ Steinhart, P., *Z. Vet.*, 45, 145, 193 (1937).

⁸ Kleitman, N., "Sleep and Wakefulness" (Chicago, 1939).

Responses of Some Marine Plankton Animals to Changes in Hydrostatic Pressure

It has generally been thought that aquatic animals, which lack gas-filled spaces in their bodies, would not perceive variations in hydrostatic pressure due to small changes in depth, since their bodies are permeated with fluid of very slight compressibility¹. Only animals possessing gas-filled spaces, such as fishes, with their swim bladders², and certain aquatic insects, with special pressure gauges connected to the tracheal system³, had been shown to respond to pressure changes, until recently. Then the discovery that decapod larvae swim upwards, in response to pressure increases⁴, suggested that tests for pressure sensitivity should be carried out on animals not known to possess gas organs.

The animals listed in Table 1 proved to be clearly sensitive. When the pressure was increased, they generally became more active and swam upwards; when it was decreased, they became less active, or completely inactive, and allowed themselves to sink. This behaviour can be termed high 'barokinesis', usually combined with negative geotaxis. The only animals observed to give an active response to a decrease in pressure (low barokinesis, combined with positive geotaxis) were the fishes and the ctenophores. Their behaviour was doubtless correlated with the fact that these animals alone were buoyant, for *Blennius* larvae have a swim bladder⁵, and healthy *Pleurobrachia* reduce their specific gravity in some other way, possibly eliminating heavy ions, as in *Halicystis*⁶. The final column of Table 1 shows the minimum change in pressure which produced a significant response in a proportion of individuals of each species. A millibar is equivalent to 1 cm. of sea water. Bracketing of a figure indicates that no smaller changes were given to the species concerned, which may therefore be much more sensitive than the bracketed figure suggests. Evidently the degree of sensitivity shown is sufficient to help these animals to control their depth.

Other workers have proved that control of depth, in copepods and cladocerans, is largely due to positive phototaxis at reduced illumination⁷. The relative importance of the light response and the pressure response was investigated by confining similar batches of animals in two vertical glass tubes, which were raised and lowered together in the sea. One was

Table 1

Class or Order	Species	Minimum change (in mb.) producing a significant response
Teleostei	Larva of <i>Blennius pholis</i>	5
Decapoda	Megalopa larvæ of <i>Carcinides moenas</i>	10
	Corresponding stage of <i>Galathea</i> sp.	10
Isopoda	<i>Eurydice pulchra</i> (pelagic during high water only)	50
Copepoda	<i>Caligus rapax</i>	(800)
Polychaeta	Larvæ of <i>Poecilochaetus serpens</i>	(800)
	Pelagic adults of <i>Autolytus aurantiacus</i>	(800)
Ctenophora	<i>Pleurobrachia pileus</i>	50
Hydromedusae	<i>Phialidium hemisphericum</i>	(800)
	<i>Gossea corynetes</i>	(800)
	<i>Eutima gracilis</i>	(800)

open to pressure changes and the other was sealed at atmospheric pressure. The vertical distribution of the animals inside each tube was recorded with the help of an 'aqualung'. So far, we have used this apparatus only with batches of *Eurydice*, which usually remained near the bottom of the tubes. They swam up only in the tube which was open to the increased pressure at greater depths (2-10 m.). The considerable reduction in light intensity, which at 10 m. was about 1 per cent of the illumination near the surface (vertical extinction coefficient 0.45), appeared to have no effect upon them.

We failed to obtain any clear responses to pressure changes in *Calanus*, *Tomopteris*, *Sagitta*, *Alloteuthis* larvæ and various small plankton animals.

There are special reasons for the pressure response being particularly useful, as a depth-regulating mechanism, to the animals listed in Table 1. The majority of these are large polychaetes and Crustacea of high specific gravity, which have to spend much of their time swimming fairly hard in order to maintain their depth. They sink rapidly during their periodic rests, so they must control the duration of each resting period, if they are to remain suspended. *Calanus*, *Tomopteris* and *Sagitta* do not sink rapidly while resting. Planktonic coelenterates are of specific gravity rather similar to that of sea water; but, if they lacked pressure responses, they would be liable to change level quite widely while resting, because they spend most of their time inactive, with their extended tentacles slowly trailing through the water. This is, of course, the way in which the majority catch their prey.

Fish have to guard against their unstable buoyancy mechanism moving them upwards or downwards, so they might be expected to be particularly sensitive to pressure changes. Nevertheless, the minimum changes to which *Blennius* larvæ responded were not much smaller than those which induced responses in decapod larvæ, and the delay between stimulus and response was generally greater in *Blennius* than in *Carcinides* and *Eurydice*. It is therefore doubtful whether possession of a swim bladder confers a particularly high degree of sensitivity to small pressure changes. No gas organs are known in any of the other animals dealt with here, and it is very unlikely that medusæ or ctenophores possess even the smallest of gas vesicles, for these would easily be visible under the microscope in such transparent animals. Some other mechanism of pressure perception must be sought. So far the only effects of hydrostatic pressure which have been observed in living tissues have been effects due to very high pressures; but these were profound and eventually lethal.

Evidently the very existence of life at the greatest ocean depths depends on special physiological adaptation to high pressure*. Considering this, it is less surprising to find evidence that changes of less than a decibar may produce effects on living tissues which are sufficiently important to be appreciated by the animals concerned; but the mechanism of perception is quite uncertain.

E. W. KNIGHT-JONES
S. Z. QASIM

Marine Biology Station,
University College of North Wales,
Bangor.
Jan. 26.

* Harris, J. E., *Quart. J. Micro. Sci.*, 94, 537 (1953).

* Harden-Jones, F. R., and Marshall, N. B., *Biol. Rev.*, 28, 16 (1953).

* Thorpe, W. H., and Crisp, D. J., *Brit. J. Exp. Biol.*, 24, 310 (1947).

* Hardy, A. C., and Bainbridge, B., *Nature*, 167, 354 (1951).

* Qasim, S. Z., *Nature* [175, 217 (1955)].

* Osterhout, W. J. V., and Dorcas, M. J., *J. Gen. Physiol.*, 7, 633 (1925). Gross, F., and Zeuthen, E., *Proc. Roy. Soc.*, B, 135, 382 (1948).

* Heilbrunn, L. V., "An Outline of General Physiology" (W. B. Saunders, Philadelphia, 1943). Kitching, J. A., *Brit. J. Exp. Biol.*, 31, 56 (1954).

* Marshall, N. B., "Aspects of Deep Sea Biology" (Hutchinson, London, 1954).

Astaxanthin in the American Flamingo

The flamingo, *Phoenicopterus ruber*, derives from its dietary carotenoids the conspicuous rich pink to red colours of its feathers, tarsal and pedal skin and lower bill-mandible. Captive flamingos gradually lose their rich pigmentation unless appropriate dietary measures are taken. The presumptive role of crustacean carotenoids in supplying pigmentation to the birds in Nature is given some support by observations in zoos¹ and by Manunta's² reported recovery of an astacene-like carotenoid from the fat of a flamingo.

In the San Diego Zoo, a flock of two dozen flamingos has received, since March 1954, finely ground carapace (plus some hypoderm) of the California 'spiny lobster', *Panulirus interruptus*, added as a regular supplement to the usual diet of beef- or horse-liver, grass-pellets, millet, wheat, rice, dried flies and ground shrimp. As a result, the American species, *Phoenicopterus ruber*, soon developed striking pink and vermilion colours in the skin (not in the transparent scales) of the tarsals, heel and webbed toes, the lower mandible and the new plumes. Three members of a smaller species, the Chilean flamingo (*P. chilensis*), exhibit bright pink skin over their heels and webbed feet, but not elsewhere; their feathers remain mostly white as in Nature, but now with a few pink ones. The rest of the general body-skin is of normal, pale appearance (like that of domestic fowls) in both species.

Although the birds receive mixed carotenoids in their diet (notably since they pluck grass as well), the various tissues yield chiefly hypophase carotenoids, and the majority of these seem to be partially oxidized xanthophylls, their chromatographic fractions giving atypical spectral absorption curves. The minor amounts of epiphasic carotenoids include no typical carotenes, but apparently oxidation products of carotenes.

No traces of astaxanthin, or of any acidogenic carotenoid, were detected among the carotenoids of the yellow-orange sub-dermal or visceral fat, the orange adrenals, the liver, pancreas, spleen, lung, muscle, immature ovary or testes of recently expired birds which had received the regular diet. Nor did the carotenoid-rich plasma of blood yield astaxanthin.

The erythrocytes contained no carotenoids. Even the blood-laden shafts of pin feathers, while rich in carotenoids, yielded no trace of the acidogenic carotenoid save for a possible trace in one sample. No carotenoids were recovered from the pale, semi-fluid contents of small or large intestine.

However, the bright pink feather barbs themselves, as well as the brilliant vermilion skin underlying the tarsal scales, yielded copious amounts of astaxanthin as a prominent fraction of the carotenoid complement. The identity of the astaxanthin was established both by the single broad maximum of its oxidized derivative, astacene, at 495–496 m μ in pyridine, matching that of astacene from *Panulirus* and other crustaceans (Beckman DU photoelectric spectrophotometer), and by mixed chromatography of the astacene derivative from skin, from feathers and from *Panulirus*. Each chromatogram alone, and the mixture of the three, appeared to be identical on columns of magnesium oxide and 'Celite'.

Hydrolysed feathers yielded no epiphasic carotenoids, but only astacene and neutral hypophasic derivatives. The skin provided three or more neutral xanthophylls of unfamiliar spectra, two minor atypical, persistently epiphasic fractions, and considerable amounts of astaxanthin.

A roseate spoonbill (*Ajaia ajaia*), receiving the same diet as the flamingoes, grew pink feathers which, after alkaline hydrolysis, yielded astacene as the predominant, if not the only, carotenoid.

The metabolic fractionation of dietary carotenoids by the American flamingo seems to involve oxidative processes as well as partial transfer of unchanged astaxanthin to the integument. A remaining puzzle involves questions as to (1) the enzymic astaxanthin-oxidizing agency, if any, residing in the gut or in the blood, which must, nevertheless, undoubtedly transport astaxanthin to the tarsal skin and plume follicles, and (2) the rate of destruction of astaxanthin en route. Experimentation continues as opportunity permits, and a full report will be published elsewhere.

I thank the following for their interest, co-operation and technical aid: at the Scripps Institution, Dr. Arthur L. Kelly, Mr. E. F. Corcoran and Mr. Elmer Squier, research assistants; at the San Diego Zoo, Dr. Charles R. Schroeder, director; Mr. K. C. Lint, curator of birds; Mr. Merl Moody, manager of the food warehouse; and my late son, Stephen, university student and summer-time assistant keeper in the bird-yard, who was accidentally killed on July 15, 1954.

DENIS L. FOX

Division of Biochemistry,
Scripps Institution of Oceanography,
University of California,
La Jolla, California. Jan. 4.

Fox, D. L., "Animal Blochromes" (Camb. Univ. Press, 1953).

Manunta, C., *Helv. chim. Acta*, 22, 1511 (1939).

Recognition of Appropriate Backgrounds by the Pale and Black Phases of Lepidoptera

THE Lepidoptera, with their frequent examples of highly specialized cryptic coloration, have been used extensively for experiments on the various aspects of evolution. More marked evolutionary adjustments have in fact been witnessed in these than in any other natural order. Thus J. B. S. Haldane¹ showed that in the Manchester district between the years

1848 and 1898, the jet-black form of the peppered moth (*Biston betularia* f. *carbonaria*) had an approximate 30 per cent advantage over pale lichen-like individuals, which were the only ones known there until the middle of the last century. Nor is this occurrence unique among the Lepidoptera of Britain. About fifty other species are, at the present time, in the process of changing their populations from light individuals to black in large areas of England.

Pollution in the air is carried great distances from industrial centres, and with the prevailing westerly wind there is a much greater contamination of foliage than has been realized. This has been demonstrated by a study of leaf washings from various parts of England (Kettlewell, unpublished work); and it appears that over the whole of eastern and south-eastern England as well as the industrial midlands there is a constant precipitation of pollution sufficient to cover vegetation and to eliminate most of the lichens and algae on tree trunks and boughs, which are now largely bare and black. E. W. Jones² has shown "that the amount of pollution by smoke is a factor that overrides all others in determining the amount of lichens present" and also the number of lichen species. Hence in many districts the number of appropriate resting sites for light-coloured insects to select in order to pass the day in relative security is being progressively restricted.

Thus it is of the greatest importance to know whether a cryptic insect, on taking up its resting position at dawn, chooses a site suitable to its colouring. Accordingly, an experiment was designed to test this possibility in its simplest form. Alternate black and white backgrounds were presented for choice. A large cider barrel was lined with alternative broad strips of black and white paper of similar consistency, so that each had the same surface area. This was covered with muslin and placed in such a position out of doors that the light fell evenly from above. Each evening three black (= f. *carbonaria*) and three pale *Biston betularia* (= f. *typical*) were released into it, and early the following morning the position of each insect was recorded. Any moth overlapping two different coloured strips by any part of its anatomy whatsoever was excluded from the scoring, as were those resting on the bottom or on the top.

A total of 198 *betularia* were released, 99 of each phenotype. Of these, 80 were disqualified for overlapping, and it is of interest that exactly half of these were of each form, so that one did not tend by habit to sit on the edges more than the other. Table 1 shows the findings for the 118 scored.

From this it can be seen that 77 *betularia* chose correct positions (38 *carbonaria* and 39 *typical*) and 41 incorrect. The 2×2 table gives a $\chi^2_{(1)} = 10.9$, for which P is approximately 0.001.

It is not suggested as probable that each phenotype actively searches areas of woodland for a correct background; but that having come to rest on a tree in its breeding area, it shifts its position so as to make the best of the local advantages offered. It

Table 1. BACKGROUND RECOGNITION IN *Biston betularia*

	Black (= <i>carbonaria</i>)	White (= <i>typical</i>)	Total
Black background	38	20	58
White background	21	39	60
Total	59	59	118

would appear, therefore, that the black and pale forms appreciate their immediate backgrounds. It is possible that they gauge the contrast differences between the colour of the scales surrounding the eyes and that received by that segment of the eye which registers the light reflected from the tree trunk. To test this, I have attempted to transplant the tufts surrounding the eye of the *carbonaria* on to the pale *typical* and vice versa, but a satisfactory technique is so far lacking.

This is the first experimental demonstration of the fact that distinct phenotypes of a moth tend to rest upon backgrounds appropriate to their colouring, a matter of much consequence in studying the micro-evolution of the Lepidoptera. Moreover, it could produce a balanced polymorphism in certain parts of a country, if the degree of pollution became constant. It must also be one of the factors which accounts for the high rate at which industrial melanism has spread in manufacturing areas.

H. B. D. KETTLEWELL

Genetics Laboratory,
Department of Zoology,
University Museum,
Oxford.
Jan. 8.

¹ Haldane, J. B. S., *Trans. Camb. Phil. Soc.*, 23, 26 (1924).

² Jones, E. W., *Rev. Bry. et Lich.*, 21, 1-2 (1952).

Genotype-Environment Interactions in *Lolium perenne*

UNTIL recently, the importance of genotype-environment interactions, though generally recognized by plant and animal breeders, has been largely neglected in most quantitative studies. Despite their possible removal by scaling¹, theoretical objections to this procedure have been made and these objections are underlined by recent results in, for example, *Drosophila*, tomato² and ryegrass³.

I have been occupied in estimating the genetic components of variation in herbage weight in *Lolium*, as determined mainly by tiller number and tiller weight, using spaced plants in the field under periodic defoliation. Significant interactions between frequency of cutting and fertility-levels on one hand, and genotype on the other, were observed early in the experiment. Significant interactions also occurred in a selection experiment between genotype and date of cutting in that the effect of recurrent selection for *high* and *low* production (green weight) in the field between spring and autumn vanished at assessments made from late autumn to winter.

For an analysis of the factors responsible, three or four representative individuals of these progenies, selected for high and low green weight, were cloned. The progenies covered a range of outcrosses and slightly inbred material. These selection groups were grown in glasshouses during the winter of 1954 under high and low temperature combined with high and low light (high temperature, approximate average: 70° F. day, 50° F. night; low temperature: 60° F., 40° F.; high light: natural light extended artificially to 16 hr. by light of 600 W. from mercury vapour and incandescent lamps; low light: natural day-length, whitewashed glasshouse). Both temperature and light fluctuated with outside conditions. All plants were harvested three times at one-monthly intervals until, after the third cut, the first signs of

reproductive development were observed under certain treatments.

Preliminary results show conspicuous interaction between selection group and temperature in different characters at all harvests, especially under 'high' light conditions. A typical example from the outcrossed group is given below for material which has been selected in two cycles for *high* and *low* weight

Table 1. GREEN WEIGHT (TILLER NO. × TILLER WEIGHT) FOR OUTCROSSED GROUP (THIRD HARVEST)
Means and stand. errors for three plants each of two clonal propagules

Selected for	Warm house	Cold house
High weight	9.3 ± 1.2 (37 × 0.26)	6.5 ± 1.2 (38 × 0.18)
Low weight	5.8 ± 1.2 (27 × 0.21)	8.8 ± 1.2 (41 × 0.22)

It is apparent that yield was raised in the high weight selection group through high temperature increasing tiller weight, and in the low-weight group through low temperature increasing tiller number.

Similar results were obtained in more homozygous material; for example, in derivatives obtained from one 'high' plant by selecting for high weight in two generations of inbreeding (selfing and sib-crossing

Table 2. GREEN WEIGHT (TILLER NO. × TILLER WEIGHT) FOR INBRED GROUP (THIRD HARVEST)
Means and stand. errors for two clonal propagules of 'high' plant

Plant No.	Warm house	Cold house
Ba 1904/18	6.6 ± 0.8 (30 × 0.23)	4.6 ± 0.8 (46 × 0.10)
Ba 1904/5	2.4 ± 0.8 (19 × 0.13)	5.8 ± 0.8 (48 × 0.12)

It is possible that such reactions to temperature are of importance in maintaining diversity in populations of perennial ryegrass in the field.

Similar interactions of genotype with light treatment were much less apparent. This is thought to be mainly due to the observed tendency—supported by the physiological trials of Mitchell⁴—that, under certain conditions, while light intensity increases tiller number and average tiller weight, high temperature decreases tiller number and increases tiller weight.

Similar responses in plant yield, tiller weight as tiller number to temperature and light intensity were found between *L. perenne* and the higher winter producing *L. multiflorum* and in short-rotation ryegrass, a synthetic strain derived from crosses between them.

The existence of 'climatic races' has been demonstrated before⁵, and their occurrence within a single population has been shown recently by similar methods in *Achillea*⁶, in mutation work in other species⁷, and in other aspects of ecotypic differentiation in *Lolium*⁸.

Whatever the origin of these differences may be, such examples stress the necessity of providing for the separation of terms for certain genotype-environment interactions of possible importance in quantitative inheritance studies. In default of these, the statistics and heritabilities estimated are relative only. The estimation of genotype-environment interactions can be very difficult in field trials, where temperatures fluctuate at different levels, unlike major temperatures or light-levels can be represented by different locations. It is suggested that temperature-levels were partly responsible for the significant interactions found by Corkill (unpublished work)

the productivity of clonal material of a wide range of ryegrass plants at three New Zealand stations at different latitudes.

Practically, these difficulties mean that, after the elimination of adaptive failures and deleterious mutations, there are serious obstacles in the way of further improvement in the average performance of pasture strains by a more precise selection towards a certain ideal type of individual with characters representing the highest yield components. Irregular changes from one temperature-level to another—similar to those discussed here—occur under New Zealand conditions within very short periods of the same season and, of course, between different years. These changes would favour different growth types so that calculation of a reliable selection index would be very complicated indeed, and would involve allowance for seasonal differences.

In the breeding of improved strains of pasture plants selection is usually carried out on spaced plants; but the strains are ultimately used under sward conditions. There are indications from this series of experiments that interactions between spacing and genotype are such that selection methods would be more successful if the effect of spacing on performance were taken into consideration.

Detailed results of the studies reported here will be presented elsewhere. I thank Mr. A. C. Glenday for constant help in statistical interpretations, and Mr. L. Corkill, chief plant breeder, and other colleagues for helpful suggestions and discussions.

S. O. FEJER

Grasslands Division,
Department of Scientific and Industrial Research,
Palmerston North, New Zealand.

¹ Mather, K., "Biometrical Genetics" (Methuen, London, 1950).

² Lewis, D., *Heredity*, 8, 333 (1954).

³ Cooper, J. P., *J. Ecol.*, 42, 521 (1954).

⁴ Mitchell, K. J., *Physiol. Plant.*, 6, 425 (1953).

⁵ Clausen, J., "Stages in the Evolution of Plant Species" (Cornell Univ. Press, Ithaca, 1951). Dobzhansky, Th., and Spassky, N., *Proc. U.S. Nat. Acad. Sci.*, 40, 407 (1954).

⁶ Hisey, W. M., *Evolution*, 1, 297 (1953).

⁷ Gustafsson, A., *Acta Agric. Scand.*, 4, 601 (1954).

⁸ Gregor, J. W., and Watson, Patricia J., *New Phytol.*, 53, 291 (1954).

Zinc in the Metabolism of *Fusarium vasinfectum* Atk.

THAT zinc is essential for the growth of *Fusarium vasinfectum* has been established by one of us (L. S. D.)¹. That the fungus produces certain phytotoxins *in vitro* and that one of them, namely, fusaric acid, possesses antibacterial properties also, has been reported earlier². The present investigation has revealed a further relationship between zinc concentrations in a purified medium and antibiotic production.

F. vasinfectum was grown in a sucrose-nitrate basal medium (KNO₃, 5.0 gm.; KH₂PO₄, 2.5 gm.; MgSO₄·7H₂O, 1.25 gm.; sucrose, 25.0 gm.; water, 1 litre) purified and amended with constant and sufficient amounts of iron, copper, manganese and molybdenum, with concentrations of zinc alone varying from 0 to 100 µgm. per flask. The amendments were added individually to 25-ml. aliquots of medium (adjusted to pH 3.0) in 500 ml. 'Hysil' conical flasks, covered, as usual, with inverted beakers³. After 15 days growth of the organism (28° C.) the antibiotic/toxic potency (expressed as fusaric acid equivalent) of culture filtrates was determined by the bio-assay method of fusarial toxin⁴, and the

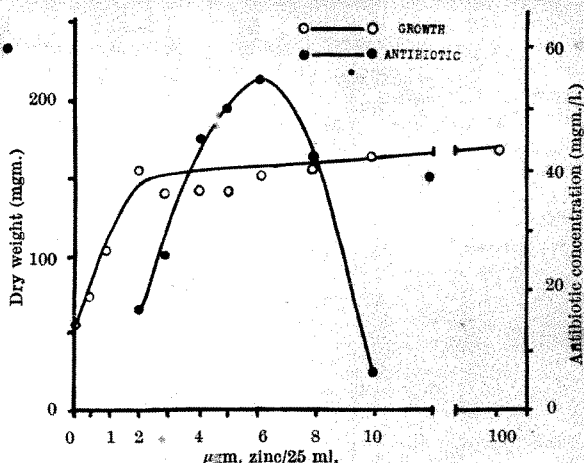


Fig. 1. Effect of zinc on the growth and antibiotic potency of *Fusarium vasinfectum* Atk.

mycelial growths were washed, dried and weighed (Fig. 1).

Fig. 1 shows the indispensability of zinc for normal growth (as indicated by dry weight) and antibiotic production; antibiotic production, however, was not detectable until the addition of 2 µgm. zinc, and peak antibiotic potency was at a much higher level of zinc than that at which the organism attained normal growth. Higher concentrations of zinc markedly reduced antibiotic production, which was completely inhibited at the 100-µgm. zinc level. Similar results have been reported for *Streptomyces griseus*⁵; but in the present case, antibiotic production appears to be inhibited at much lower levels of zinc than in *S. griseus*.

Further investigations with higher initial levels of pH (adjusted before autoclaving) and different periods of incubation are under way.

We are indebted to Prof. T. S. Sadasivan for valuable help.

R. KALYANASUNDARAM
L. SARASWATHI-DEVI

University Botany Laboratory,
Madras 5. Jan. 19.

¹ Saraswathi-Devi, L., *Proc. Ind. Acad. Sci.*, B (in the press).

² Gäumann, E., St. Naef-Roth, and Kobel, H., *Phytopath. Z.*, 20, 1 (1952).

³ Saraswathi-Devi, L., *Proc. Ind. Acad. Sci.*, 40, B, 1 (1954).

⁴ Kalyanasundaram, R., *J. Ind. Bot. Soc.* (in the press).

⁵ Chesters, C. G. C., and Rolinson, G. N., *J. Gen. Microbiol.*, 5, 559 (1951).

Nicotine Degradation *in vitro* induced by Agents from Tobacco Seed

It has been recorded in the literature that nicotine, if brought in contact with tobacco seeds, undergoes a gradual decomposition^{1,2}. The nature of the chemical reactions involved, and of the agents that initiate these reactions, have remained obscure. The following preliminary results during detailed investigations of this effect in our laboratory have been obtained.

In the course of thirty to fifty hours at room temperature, nicotine in aqueous solutions of 10⁻³ to 10⁻² molarity, neutralized with sulphuric acid to pH 7, is converted, in the presence of sterilized air, into a series of degradation products on addition of a small volume (5-10 per cent. of the volume of the main solution) of water that had previously been passed

at room temperature through a layer of non-ground tobacco seeds.

At least six substances can be distinguished among the successively appearing transformation products of the alkaloid, by chemical, spectrophotometric and chromatographic methods. One of the products has been identified as γ -keto- γ (3-pyridyl)butyric acid, first isolated by Wada and Yamasaki³. A second substance, characterized by two ultra-violet absorption maxima (230 and 290 m μ), appears to be a substituted pyridone. Two additional substances have the properties of glutamic acid derivatives, and the final degradation products are ammonia, methylamine and simple aliphatic dicarboxylic acids. The successive appearance of these substances indicates that the degradation starts with the oxidative opening of the pyrrolidine ring of the nicotine molecule, and proceeds with the oxidative rupture of its pyridine moiety, via the intermediate formation of pyridones.

Two agents contained in the seed washings are necessary for these effects, namely, (a) micro-organisms present on the seed surface, and (b) a heat-resistant substance or substances removable by water from the seed. The quantities of (b) required for continuous degradation of nicotine increase with the concentration of the nicotine solution.

Air-borne micro-organisms can replace, under certain conditions, the micro-organisms obtained from the seed; but they also require for continuous action the heat-resistant supplement (b).

This deep-seated chemical destruction of nicotine under the influence of agents associated with tobacco seeds might be in some way related to the known absence of nicotine and other pyridine derivatives in tobacco seed. Considering the possibility that a reversal of the observed degradation reactions may occur in the presence of a reducing enzyme system and of hydrogen donors, such nicotine formation from simple compounds may represent a model of the natural nicotine synthesis in the tips of the rootlets emitted from the sprouting tobacco seed.

WALTER G. FRANKENBURG

Research Laboratory,
General Cigar Co., Inc.,
Lancaster, Pennsylvania.
Jan. 19.

¹ Wenusch, A., *Z. Lebens. Unters. u. Forsch.*, **88**, 251 (1943).

² Private communication from Wahl, D. R., Tabakforschungsinstitut (Forchheim, Germany).

³ Wada, E., and Yamasaki, K., *J. Amer. Chem. Soc.*, **76**, 115 (1954).

Identity of the Acetylcholine-like Substance in the Housefly

THE hypothesis that the organophosphate insecticides kill insects by inhibiting the cholinesterase of the nervous system has been questioned, partly on the grounds that acetylcholine has not been demonstrated in insects¹. That insects contain a substance with pharmacological activity similar to acetylcholine has been amply demonstrated²; but the identity of this substance remains in doubt. Chemical methods have indicated that the substance is not acetylcholine³; on the other hand, combined chromatography and pharmacological methods have indicated that the substance is acetylcholine⁴. We have used the chemical method, chromatography and electrophoresis to examine the pharmacologically active substance extracted from the housefly, *Musca domestica* L. The results show

consistently that the acetylcholine-like substance in the housefly is identical with acetylcholine itself.

Flies were decapitated on solid carbon dioxide and the heads (10–15 gm. for each experiment) homogenized in 0.01 per cent eserine. Homogenates were deproteinized with trichloroacetic acid, and the supernatant extracted with ether and reduced to dryness *in vacuo*. The residue was extracted with acidified ethanol, and the ethanol removed by a stream of air, leaving a sticky brown residue.

Paper electrophoresis was used for separating the active substance from the extracts. Using lithium sulphate as the electrolyte, two bands moved to the cathode leaving most of the interfering material at the origin. Pharmacological tests, using the frog rectus abdominis, showed activity present in band 2, none in band 1, and only traces on the rest of the paper.

Sections of the electrophoresis strips corresponding to the location of the bands were cut out, eluted and chromatographed. For comparison, we chromatographed reagent acetylcholine bromide, and acetylcholine bromide which had been run parallel with the extract through the electrophoresis procedure. Fig. 1 shows the results. Band 1 (E_1) was resolved as a single compound which other tests, outlined below, indicate to be choline. Band 2 (E_2) was resolved into two components (the faint, lowest spot seems due to incomplete separation from band 1). The identity of the fast-moving component is unknown. The other component had an R_F identical with that of acetylcholine sulphate subjected to the same electrophoresis procedure as the extract. The R_F of acetylcholine bromide was considerably higher;

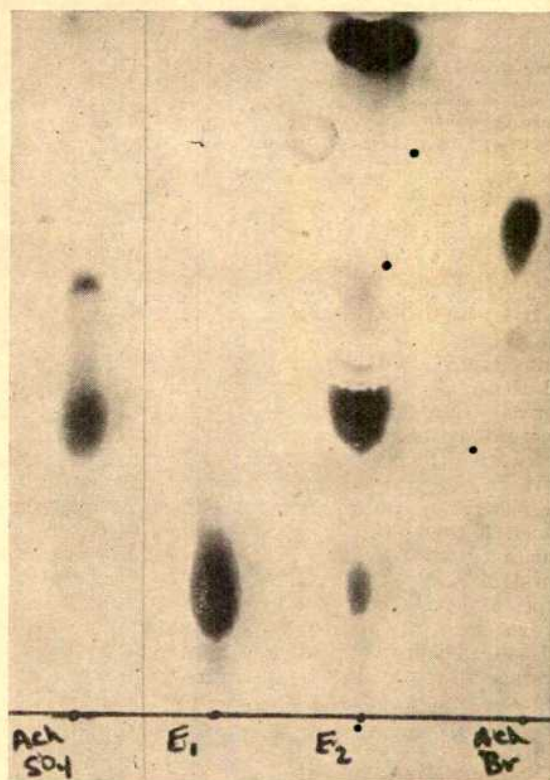


Fig. 1. Paper chromatogram of: eluates from bands 1 and 2 (E_1 and E_2) obtained by electrophoresis of housefly extracts; acetylcholine after electrophoresis in lithium sulphate (ACh SO₄); acetylcholine bromide (ACh Br). Solvent, butanol/acetic acid/water (4:1:5). Chromatogram sprayed with phosphomolybdic acid followed by acidic stannous chloride.

others⁵ have observed that the anion influences the R_F of acetylcholine. It seems reasonable to conclude that the valid comparison is between the extract and acetylcholine treated in the same way, and that this comparison indicates the presence of acetylcholine in band 2. Pharmacological activity was found only in the region of the spot with R_F identical with that of acetylcholine after electrophoresis.

Hestrin's chemical method⁶ was applied to eluates from bands 1 and 2. The material from band 2 gave an absorption spectrum identical with that of acetylcholine; band 1 was negative for choline esters.

Paper electrophoresis was used further for examining the active substance separated in band 2. When acetylcholine bromide was added to an eluate of band 2, the mixture moved as a single band without separation. After treatment of unesterized homogenates with purified bovine acetylcholinesterase, band 2 was absent; on re-electrophoresis, the remaining band 1 showed the same mobility and colour reaction as choline.

W. CHEFURKA
B. N. SMALLMAN

Science Service Laboratory,
Canada Department of Agriculture,
London, Ontario.
Dec. 15.

¹ Hopf, H. S., *Ann. App. Biol.*, 41, 248 (1954).

² Corteggiani, E., and Serfaty, A., *C.R. Soc. Biol.*, 181, 1124 (1939).
Tobias, J. M., Kollros, J., and Savit, J., *J. Cell. and Comp. Physiol.*, 28, 159 (1946).

³ Prosser, C. L., in "Nerve Impulse", 51 (Josiah Macy, Jr. Foundation, 1952).

⁴ Lewis, S. E., *Nature*, 172, 1004 (1953).

⁵ Whittaker, V. P., and Wijesundera, S., *Biochem. J.*, 51, 348 (1952).

⁶ Hestrin, S., *J. Biol. Chem.*, 180, 249 (1949).

A Reliable Physiological Index for evaluating Summer Clothing

A SEARCH for a reliable physiological index to evaluate the comfort of summer clothing was begun during the Second World War and is still being continued. Many indices have been tried for this purpose¹; but all these can at best reveal significant differences between the clothed and the nude state, or between two grossly different types of clothing. In a preliminary investigation² this fact was confirmed.

We have now used an evaporative cooling index suggested by Paintal (personal communication, 1953) which is remarkable for its simplicity and reproducibility and which, in fact, reveals differences that are significant at the 1 per cent level between different types of clothing in everyday use. This index, which is based on the principle that human comfort is related to skin temperature, is expressed as the average drop in skin temperature of the trunk in degrees 6 min. after exposure of the trunk fully covered with sweat to a streamlined flow of air at 300 ft./min.

The experiments were carried out in an air-conditioned room at dry bulb $95.0^\circ \pm 1.0^\circ$ F. and 60 ± 3 per cent relative humidity. Shirts made of three types of fabrics were used: (i) white muslin kurta (a type of Indian shirt); (ii) olive-green bush-shirt of cellular material; and (iii) olive-green bush-

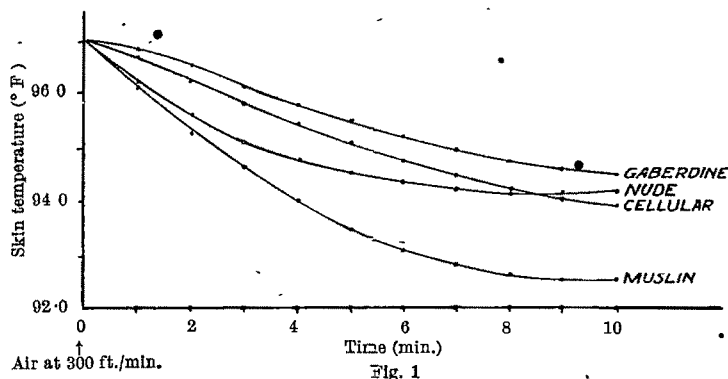


Fig. 1

shirt of U.K. jungle gaberdine. Olive-green drill trousers were worn in each case. Ten subjects were used for this series of experiments.

Thermocouples were strapped to four points on the trunk and the subject then donned the shirt under trial with the standard trousers. He then cycled on a cycle ergometer for 15 min., by which time his trunk was fully covered with sweat. The subject then sat in an erect posture on a stool facing (but shielded from) a source of streamlined current of air at 300 ft./min. Skin temperatures at four points were recorded and the air was turned on his trunk. Thereafter skin temperature was recorded at each point at intervals of 1 min.

Fig. 1 was plotted after averaging sixty readings on ten subjects. For purposes of comparison, the curves have been adjusted to start from the same initial temperature of 97.0° F., as the significant observation was the drop in skin temperature, and the exact initial temperature, therefore, really did not matter. As shown in Fig. 1, the fall in skin temperature by the sixth minute with subjects unclothed and wearing muslin kurta, cellular bushshirt and gaberdine bushshirt were respectively 2.7, 4.0, 2.3 and 1.8 deg. F. Statistical analysis of the whole of the results shows that differences significant at the 1 per cent level occurred between the three types of dresses. It is, therefore, evident that muslin would be the 'coolest' fabric to wear in summer—a point of interest since it has been in use in India for several centuries. The advantage of being mosquito-proof afforded by U.K. jungle gaberdine is probably outweighed by the resistance it offers to cooling of the skin.

Several different types of fabrics have now been tried out, and the results will be reported in detail elsewhere.

We are grateful to Dr. A. S. Paintal for many valuable suggestions and to Mr. N. K. Chakravarty for statistical analysis of the results.

B. L. PERTI
B. B. LAL

Technical Development Establishment,
Kanpur, India. Nov. 22.

¹ Robinson, S., Turrell, E. S., and Gerking, S. D., *Amer. J. Physiol.*, 143, 21 (1945). Hutchinson, J. C. D., "Physiological Tests on Flying Clothing for use in the Tropics", Flying Personnel Research Committee Report No. 624 (1945). Kitching, J. A., and Page, E., "Review of the Work of the Subcommittee on Protective Clothing (1942-45)", Associate Committee on Aviation Medical Research, National Research Council of Canada, S.P.C. Report No. 197 (1945). Weiner, J. E., *Brit. Med. Bull.*, 5, 20 (1947). Robinson, S., and Belding, H. S., "Protective Clothing in Advances in Military Medicine", 2, 497 (Little, Brown and Co., Boston, 1948). "Applied Physiological Research on Clothing Problems", Paper presented by U.K. to the 4th Commonwealth Defence Conference on Clothing and General Stores, England (1953).

² "Physiological Criteria for the Assessment of Tropical Clothing", issued by Director of Technical Development (Army Headquarters, New Delhi), Report No. Physio/Int/53/4 (1953).

Internal Friction of White Tin Single Crystal

B. CHALMERS¹ noted the existence of α - and β -ranges in the curve of creep-rate versus stress for a white-tin single crystal.

I have made a single crystal of 99.93 per cent pure tin and measured the relation between Q^{-1} and strain amplitude of this crystal at various temperatures by F. Foerster and W. Koester's method². The specimen was 2.5 mm. in diameter, 8 cm. long, and had a fundamental frequency of 1.5 kc./sec. Its axis made angles of 6.3° and 7.2° with [001] and [100], respectively.

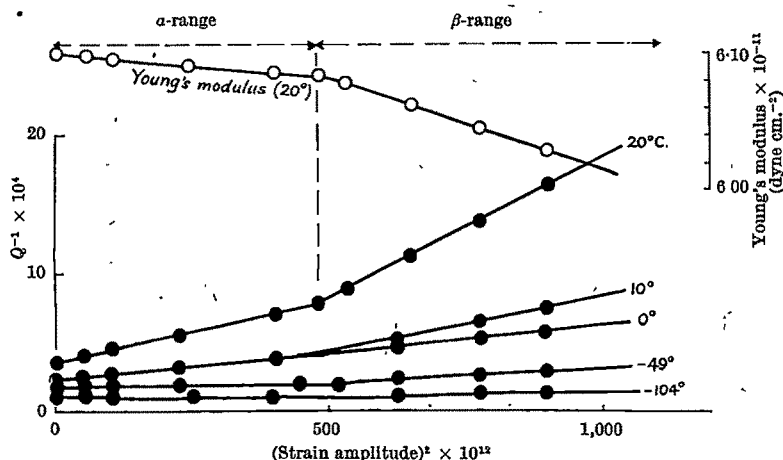


Fig. 1. ●—●, Q^{-1} ; ○—○, Young's modulus

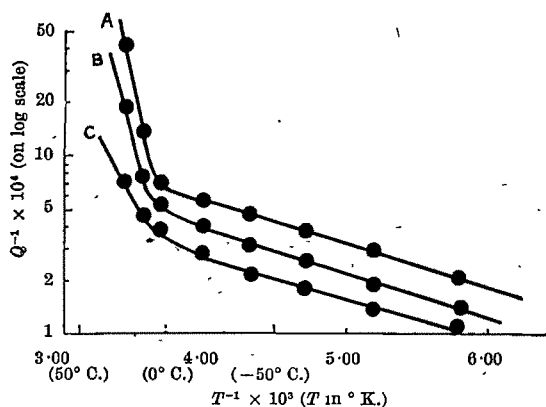


Fig. 2. $\log Q^{-1}$ as a function of T^{-1} at the following different strain amplitudes: (A) 40×10^{-6} , (B) 30×10^{-6} , (C) 20×10^{-6}

The critical points in Q^{-1} and Young's modulus curves in Fig. 1 correspond to that in Chalmers's creep-rate curve. In the α -range, Q^{-1} depends on the strain amplitude at higher temperatures, but its dependency is small at lower temperatures.

As seen in Fig. 2, at low temperatures the relation between $\log Q^{-1}$ and $1/T^{\circ}K.$ is linear; but this is not the case above the recrystallization temperature.

A more detailed description of this work will be published elsewhere. I thank Prof. T. Okuda for his guidance.

TORANOSUKE KOMATA

Department of Physics,
Polytechnic Institute,
Osaka City University.
Dec. 20.

¹ Chalmers, B., *Proc. Roy. Soc., A*, 156, 427 (1936).

² Foerster, F., and Koester, W., *Z. Metallkunde*, 29, 109 (1937).

A New Method for measuring Electrical Resistivities

A NEW method for the measurement of electrical resistivities of conductors has recently been developed in this laboratory by inducing a momentary electromotive force in a plane uniform ring of the conductor suitably suspended in a homogeneous magnetic field and observing the resultant ballistic throw. In the actual experiments, the field was horizontal and the ring was suspended from a torsion fibre with its plane vertical and with its axis at an angle of 45° to the direction of the field. When the field is switched off in an interval of time very small compared to the time-period of the suspension, the ballistic kick θ is given by

$$\theta = \frac{A^2 TH^2 a}{8\pi I \rho L}$$

in which I is the moment of inertia and T the period of oscillation of the suspension, A is the area of the ring, a the area of its cross-section and L its circumference, H is the magnetic field, and ρ is the resistivity. (The effect of the field on the resistivity is ordinarily negligible.)

This expression has been used by us for determining the resistivity of copper at room temperature. The result obtained, namely,

1.83×10^{-6} ohm cm. at 25° C., agrees well with the known value of the resistivity of copper. The method will be particularly useful for investigating conductors to which terminals are difficult to attach.

We thank Sir K. S. Krishnan, director of the National Physical Laboratory of India, for his interest in this work.

K. G. RAMANATHAN
J. S. DHILLON

National Physical Laboratory of India,
Hillside Road,
New Delhi 12.
March 22.

Focusing of Waves in Radio Reception

THE normal maximum field-strength in Kent of the broadcast transmission on 9,700 kc./s. (30.93 metres) from Sofia in undisturbed propagation conditions, and at times of the evening or night when 9.7 Mc./s. is about the optimum working frequency for the transmission path by single refraction in the F_2 layer, is about 1.0–1.5 millivolts per metre (Fig. 1). The aerial power of the Sofia transmitter is believed to be 120 kW. approximately, and the calculated quasi-maximum field-strength in conditions of minimum absorption agrees fairly closely with this field-strength being obtained at the path-distance involved.

In late 1952, an isolated observation was recorded by chance, in which the strength of Sofia appeared very greatly to exceed the normal value. Other similar abnormally high field-strengths were observed in 1953. In May and June a special watch was kept

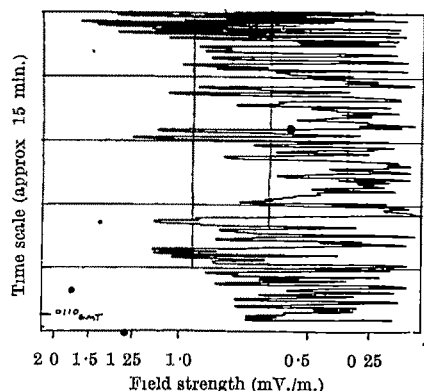


Fig. 1. Recording of normal peak reception from Sofia on 9,700 kc/s. on June 15, 1953, from 0110 hr. G.M.T.

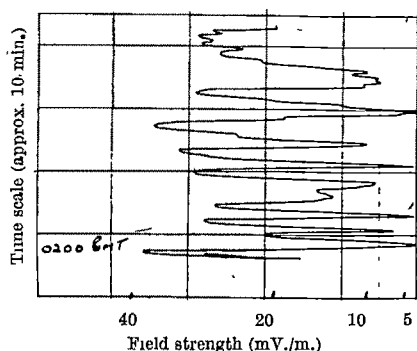


Fig. 2. Example of 'focused' reception from Sofia on 9,700 kc/s. on June 25, 1953, from 0200 hr. G.M.T.

for these occurrences, in which the field-strength received was considerably greater than that to be expected if only the inverse-distance law were taken into account, neglecting absorption. The phenomenon was then noted on only three nights in twenty-nine and its duration was from ten to twenty minutes approximately. Before the exceptional condition occurred, the field-strength increased slowly in the normal manner to the usual 1-1.5 millivolts/metre 'peak' value, remaining at about this figure for about an hour. Then the strength again improved rapidly to the 'abnormal peak', during which peak measurements of 20-30 millivolts/metre were not uncommon, with intervening troughs of fading (Fig. 2). Finally, the signal weakened rapidly, becoming stabilized for a few minutes about the normal high value around 1 millivolt/metre and then declining quickly toward much lower strengths of about 50 microvolts/metre. This final decline was a normal condition in the early morning, probably as the signal began to penetrate the *F*-2 layer, because the frequency was about the maximum usable frequency. Only the high 'abnormal peaks' were in any way unusual or unexpected.

Field-strength recordings were made of the normal and abnormal maximum fields on different nights, and the information was given to some other interested workers, special observations being discontinued thereafter. The phenomenon continued to be evident at intervals, though perhaps rather less often than the 10 per cent of nights noted above. More recently, abnormal peaks around 22 millivolts/metre were measured in the period 0415-0425 G.M.T. on November 30, 1954.

The effect has been ascribed to some form of ionospheric 'focusing'; but the increase in strength by a factor of about 20:1 (which would correspond with an effective power increment of four hundred times the normal) seems extraordinarily large. It has been observed on other transmissions from the eastward, but very rarely and in a less pronounced degree, suggesting that the most favourable condition for such focused propagation is from the south-eastward.

H. V. GRIFFITHS
(Engineer-in-Charge)

B.B.C. Engineering Information Department,
Tatsfield Receiving Station,
Near Westerham, Kent.
Dec. 30.

Thunderstorm Signals at Very-high Frequency and Ultra-high Frequency

WHILE signals from distant very-high and ultra-high frequency transmitters were being monitored on June 26, 1954, a thunderstorm occurred in the region of the receivers. The transmitters, which operated at 49, 91, 173 and 492 Mc/s., were some two hundred miles from the receiving site. Fig. 1 shows a portion of the signal amplitude records obtained during the storm. The speed of response of the receivers was limited by one half-second time constant of the recorders. A single five-element Yagi antenna was used with each of the 49, 91 and 173 Mc/s. receivers, and a twelve-foot paraboloid reflector antenna was used with the 492 Mc/s. receiver. All antennae were horizontally polarized and were directed towards the transmitters.

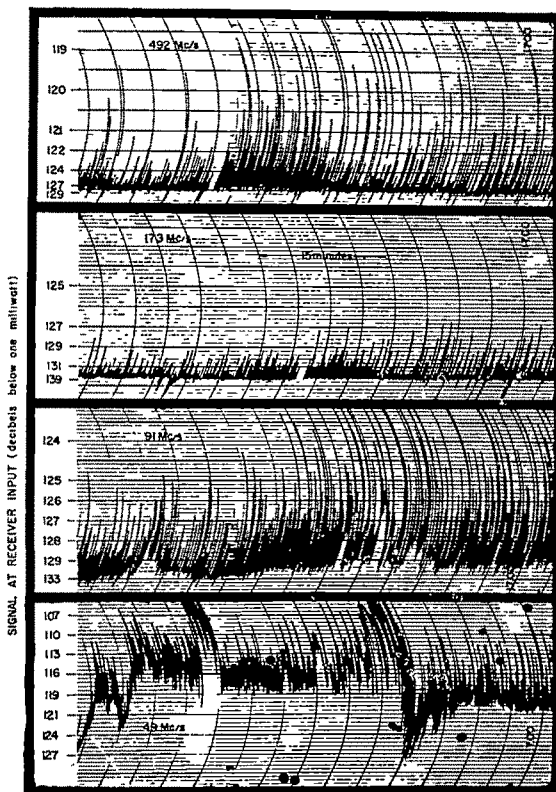


Fig. 1

Although other reports on very-high and ultra-high frequency signals during a thunderstorm have been published recently¹, it is believed that these are the first records which offer a comparison of the relative amplitudes over a wide part of the spectrum. The normal, slowly fading signals changed into a continuing series of rapid impulses during the storm. Although the 91 and 173 Mc./s. transmissions stopped during the storm, there was no apparent change in the nature of the records at that time. Further, the hourly silence period in the 49 and 492 Mc./s. transmissions was not recorded during the storm. It would appear that most of the recorded signals were due to noise originating from the thunderstorm rather than signal from the distant transmitters.

This work was carried out under project PCC D48-28-01-03.

D. R. HAY
T. R. HARTZ

Defence Research Telecommunications
Establishment,
Radio Physics Laboratory,
Defence Research Board,
Ottawa.
Jan. 28.

¹ Isted, G. A., *Nature*, 171, 617 (1953). Hewitt, F. J., *Proc. Phys. Soc.*, B, 61, 895 (1953). Tilton, E. P., *QST*, 38, 61 (1954).

Infra-red Spectrum of the Night Sky near 10000 Å.

We have recently obtained infra-red spectra of the night sky using the newly improved Kodak IZ(2) plates. An exposure of 48 hr. was sufficient to bring up a considerable number of lines on a hypersensitized plate. An $f/0.8$ auroral spectrograph described elsewhere¹ was employed. A microphotometer tracing of a typical plate is shown in Fig. 1. The spectral slit width was 4.5 Å.

The measured wave-lengths of the stronger features are recorded in Table 1. Almost all the features can be attributed to lines and branches of the (5,2), (4,1), (3,0), (9,5) and (8,4) OH rotation-vibration bands. The predicted wave-lengths (in air) for the lines of the (5,2), (4,1) and (3,0) bands were calculated from the energy-level data of Dieke and Crosswhite² and of Herman and Hornbeck³. The predicted wave-lengths of the $Q(1)$, $P_1(2)$ and $P_1(3)$ lines of the (9,5) band and the $Q(1)$ line of the (8,4) band were calculated by means of the combination principle from the wave-lengths of the observed lines of the (9,4),

Table 1. WAVE-LENGTHS OF NIGHT SKY EMISSIONS 9500 Å.-11000 Å. (Air) Å.

Identification	(calculated; air)	obs.-calc.
10972.2	$P_1(3)$ (5,2) OH	10972.3
10923.3	$P_1(2)$ (5,2) OH	10923.3
10831.6	$Q(1)$ (5,2) OH	10831.6
10750.2	$R_1(1)$ (5,2) OH	10751.0
10730.0	$R_1(2)$ (5,2) OH	10729.0
10709.5	$R_1(3)$ (5,2) OH	10711.4
10470.0	$P_1(4)$ (4,1) OH	10469.1
10419.4	$P_1(3)$ (4,1) OH	10418.4
10396.3	$P_1(2)$ (4,1) OH	10396.8
10372.3	$P_1(1)$ (4,1) OH	10373.0
10348.3	$P_1(2)$ (4,1) OH	10347.5
10287.5	$Q(1)$ (4,1) OH	10286.9
10228.0	$R_1(1)$ (4,1) OH	10230.7
10209.9	$R_1(2)$ (4,1) OH	10224.3
10190.9	$R_1(3)$ (4,1) OH	10211.2
10172.0	$P_1(4)$ (9,5) OH	10190.0
10125.1	$P_1(3)$ (9,5) OH	10171.4
10086.4	$P_1(2)$ (9,5) OH	10124.9
10015.1	$Q(1)$ (9,5) OH	10087.9
9951.0	$R_1(1)$ (9,5) OH	10018.9
9917.2	$R_1(2)$ (9,5) OH	9958.7
9895	$P_1(3)$ (3,0) OH	9940.9
9874.7	$P_1(2)$ (3,0) OH	9915.6
9848	$P_1(1)$ (3,0) OH	9897.1
9796	$Q(1)$ (3,0) OH	9872.3
9485	$P_1(3)$ (8,4) OH	9849.4
9381	$Q(1)$ (8,4) OH	9791.6
9320	$R_1(1)$ (8,4) OH	9483
	$R_1(2)$ (8,4) OH	9383
		9330
		9319.3

(4,0) and (5,0) bands^{4,5}. The wave-lengths of the remaining lines of the (9,5) and (8,4) bands were calculated by means of the extrapolated B , Y and D values given by Herman and Hornbeck³. The calculated wave-lengths of the rotational lines are given in Table 1 and are indicated in Fig. 1.

Spectra in this region have been previously obtained by Krasovski and Lukashenia⁶, using an infra-red image converter. Krasovski and Lukashenia^{6,7} discussed the identification of the emissions with the OH rotation-vibration bands and concluded that the agreement was not altogether satisfactory.

The present work, as may be seen from Table 1 and Fig. 1, indicates excellent agreement between the observed and calculated wave-lengths for the OH bands.

As noted by Krasovski and Lukashenia, the Q branch of the (3,0) band seems to be abnormally weak. It is definitely present, however; moreover, the lines of this band have the same appearance as those of the other OH bands. The R branch of this band also appears to be present in the microphotometer trace. Many other weaker features in the microphotometer trace correlate well with the calculated spectrum.

The diffuse feature at 9951 Å. has about the same intensity as the Q branch of the (9,5) band at 10015.1 Å., whereas the R branches of the (5,2) and

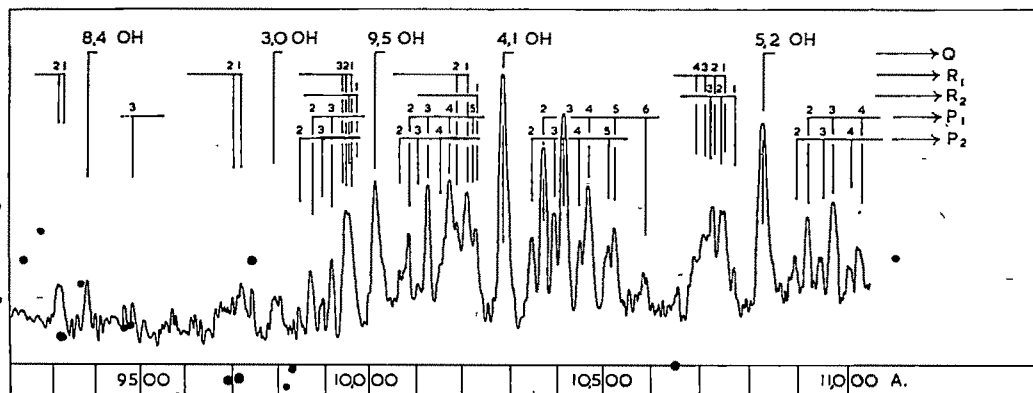


Fig. 1

(4,1) bands are considerably weaker than the Q branches. This effect seems, however, to be a consequence of the more rapid convergence of the lines of the R branch of a $\Delta v = 4$ band compared with the $\Delta v = 3$ bands. There is no evidence that the (0,2) atmospheric oxygen band (9967 Å.) is present with any intensity, since this band should give rise to maxima near 9948 and 9986 Å.

It is also satisfactory to note that there is no sign of the (10,6) band, which would fall in this region if it were present.

In view of the general appearance of the bands and of the excellent agreement between observed and calculated wave-lengths, there can be little doubt that the night-sky emission in this region is almost entirely due to the OH rotation-vibration system.

The investigation reported here has been sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under Contract AF 19(122)-152.

A. VALLANCE JONES

Physics Department,
University of Saskatchewan,
Saskatoon, Sask.

- Petrie, W., and Small, R., *Astrophys. J.*, **116**, 493 (1952).
 Dieke, G. H., and Crosswhite, H. M., Bumblebee Report No. 87 (Applied Physics Lab., Johns Hopkins University, 1948).
 Herman, R. C., and Hornbeck, G. A., *Astrophys. J.*, **118**, 214 (1953).
 Meinel, A. B., *Astrophys. J.*, **111**, 555 (1950).
 Petrie, W., Scientific Report AR-8 Geophysics Research Division Air Force Cambridge Research Center Contract AF 19(122)-152.
 Lukashenia, V. T., and Krasovski, V. I., *Dok. Akad. Nauk. SSSR.*, **79**, 241 (1951).
 Krasovski, V. I., and Lukashenia, V. I., *Dok. Akad. Nauk. SSSR.*, **80**, 735 (1951).

Identification of Water-Masses by their Suspended Matter

In the often very difficult task of following the movements of coastal and oceanic water masses, much use has been made of the temperature, the salinity and the amount of oxygen in solution. In special cases the concentrations of silica or of hydrogen ions may give useful information.

The transparency is important, and Jerlov's brilliant work on the Swedish Deep Sea Expedition of 1947-48, and in Swedish coastal waters, has shown the great value of the visual determination of the scattering of light in the Tyndall beam as a guide to the amount and type of suspended matter. Poole and Atkins, too, have studied this scattering using a photomultiplier tube, set at various angles to the beam, the light of which they found was mainly scattered forward.

During September 1951-July 1954 we filtered water, usually two litres, from station E1, 10 miles south-west of the Eddystone, through collodion ('Gradocol') disks. Photographs of such disks were prepared¹, and we pointed out that the diffuse reflexion (albedo) of the disks relative to a similar disk treated with distilled water was a good measure of the amount of suspended matter. Save during a phytoplankton outburst, the intensity and colour of the disks were only slightly influenced by the living cells, which if necessary can be decolorized in 80 per cent aqueous acetone.

The basis of the suspension was an amorphous mud, usually some shade of grey. The albedo was determined photoelectrically; and using blue, green

and red light filters we obtained colour factors also². But with the aid of colour charts, such as those of Klincksieck and Valette, or of Ridgway, such as could quite easily be used at sea, we were also able to describe the grey, yellowish or even chocolate colour of the disks, various samples matching Klincksieck's³ Nos. 115-120, 128, 142, 147, 153D, and Ridgway's⁴ Plate 3, Nos. 12, 15, 18, 19, 20, 23. In October 1952 and 1953, the light buff to chocolate tint was observed when the water had become isothermal. This is probably due to a ferruginous suspension, such as might have come from the Lower Old Red Sandstone of the nearest land or—as it appeared infrequently—from the Permian Red Sandstone between Torquay and Exmouth.

The petrological examination of the suspended matter has been undertaken by Dr. A. G. Lowndes, who kindly identified some of the particles for us. Especially important was his finding of the very insoluble microcline on disks from station E1, on March 29, 1954. Its refractive index is low, 1.52. It was most abundant on the 5-m. disk; this suggests that it had come out in fresh water and was slowly settling. He directed our attention to the fact that this mineral has one cleavage plane developed more strongly than the other two, and so tends to split into small plates which settle only slowly. Such suspended matter may therefore be carried very far from land, as may also the fine amorphous suspension, which Dr. Lowndes found to be kaolin.

W. R. G. ATKINS

PAMELA G. JENKINS

Department of General Physiology,
Marine Biological Laboratory,
Plymouth.
Jan. 18.

- ¹ Atkins, W. R. G., and Jenkins, Pamela G., *J. Mar. Biol. Assoc. U.K.*, **31**, 503, Fig. 8 (1953) Atkins, W. R. G., Jenkins, Pamela G., and Warren, F. J., *ibid.*, **33**, 501, Fig. 1 (1954).
² Atkins, W. R. G., and Eoole, H. H., *Sci. Proc. Roy. Dublin Soc.*, **20** (4), 13 (1931).
³ Klincksieck, P., and Valette, Th., "Code des Couleurs" (Paris, 1908).
⁴ Ridgway, E., "A Nomenclature of Colours for Naturalists" (Boston, 1886).

Antioxidant Activity of Redox Dyes

FURTHER evidence has been obtained to support the hypothesis that certain redox dyes, having partial vitamin E activity, can inhibit the catalytic action of hæmatin in the oxidation of unsaturated fats¹.

It has previously been shown² that methylene blue inhibits *in vitro* hæmatin-catalysed oxidation of unsaturated fats. In the present work the effect of new methylene blue, malachite green, rosaniline, Bindschedler's green and methyl violet on the rate of cod-liver oil oxidation catalysed by $5 \times 10^{-4} M$ hæmatin, at 37°C., was determined by this same method³. The concentration of each dye causing inhibition of the oxidation reaction is given in Table 1. These results demonstrate that all these

Table 1. INHIBITION OF HÆMATIN-CATALYSED OXIDATION OF COD-LIVER OIL BY REDOX DYES.

Redox dye	Conc. of dye, $\times 10^{-4} M$	Inhibition (per cent)
Malachite green	12.5	28
Rosaniline	9.2	50
Methyl violet	8.7	50
New methylene blue	6.5	50
Bindschedler's green*	6.4	50

* Dissolved in 25 per cent (vol./vol.) aqueous pyridine.

dyes are relatively good inhibitors of *in vitro* haematin-catalysed oxidation of unsaturated fat.

Since the haematin compounds are the predominant catalysts occurring in animal tissues³ for the oxidation of unsaturated fats, the ability of these redox dyes to replace vitamin E in the diet of rats is probably a function of their antioxygenic properties, and more specifically, of their inhibitory effect on the haematin-catalysed oxidation of unsaturated fats.

Haematin is capable of chemical combination with many nitrogenous bases, through its iron atom, to form hemichromes. It is probable that these redox dyes, all of which contain basic nitrogen atoms, react with haematin to form hemichromes which are not catalytic. The direct interaction of haematin with methylene blue is also indicated by the fact that the absorption spectrum of a mixture of methylene blue and haematin is considerably different from that of the summation of the absorption spectra of the individual compounds.

Besides direct reaction of these redox dyes with haematin, two other mechanisms might be operative *in vivo*. The oxidation-reduction potential of most animal tissues and organs is sufficiently negative in comparison to that of the redox dyes to account for the existence of the leuco form *in vivo*. These leuco dyes might function by inhibiting the oxidation of unsaturated fats by terminating the free-radical chain-reaction. Alternatively, the dyes might serve to regenerate α -tocopherol from a reversible oxidation product, like α -tocopheroxide, and thus allow the re-use of otherwise subminimal amounts of vitamin E.

V. P. MAIER
A. L. TAPPEL

Department of Food Technology,
University of California,
Davis, California.
Jan. 5.

¹ Moore, T., Sharman, I. M., and Ward, R. J., *Biochem. J.*, **53**, xxxi (1953); **54**, xvi (1953); **58**, vii (1954); *Proc. Nutr. Soc.*, **12**, v (1953).

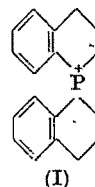
² Tappel, A. L., *Arch. Biochem. Biophys.*, **50**, 473 (1954).

³ Tappel, A. L., *Food Res.*, **18**, 104 (1953).

An Optically Active Spirocyclic Phosphonium Salt

THE tetrahedral disposition of the 4-covalent phosphorus atom has been confirmed by the optical resolution of (a) a tertiary phosphine oxide, of type $abcPO$, by Meisenheimer *et al.*¹, (b) a tertiary phosphine sulphide, $abcPS$, by Davies and Mann², and (c) a quaternary phosphonium salt, $[abcdP]^+I^-$, by Holliman and Mann³. No spirocyclic phosphonium salts, in which the two ring systems consist solely of carbon atoms apart from the phosphorus atom which is necessarily common to both, have, however, hitherto been recorded.

The comparatively ready synthetic methods by which analogous spirocyclic arsonium salts⁴ have been prepared cannot be successfully applied to the phosphonium salts. By a much longer route, however, we have synthesized *dl*-P-spiro-bis-1:2:3:4-tetrahydrophospholinium iodide⁵ (I), melting point 294–295°. The optical resolution of this dissymmetric cation has been achieved by the fractional crystallization of its *l*-menthoxyacetate, and we have thus isolated the *d*-iodide, melting point 246–248°, $[M]_D + 66^\circ$, and the *l*-iodide, melting point 246–248°, $[M]_D - 65^\circ$, both rotations determined in chloroform



(I)

solution. These rotations showed no change after the solution had been set aside at room temperature for four days.

F. G. MANN
F. A. HART

University Chemical Laboratories,
Cambridge.
April 2.

¹ *Ber.*, **44**, 356 (1911); *Annalen*, **449**, 224 (1926).

² *J. Chem. Soc.*, 276 (1944).

³ *J. Chem. Soc.*, 1634 (1947).

⁴ Lyon and Mann, *J. Chem. Soc.*, 30 (1945). Holliman and Mann, *J. Chem. Soc.*, 45 (1945).

Correction of 'Crude-Fibre' Estimation for the Effect of Altitude

IN the estimation of crude fibre at altitudes appreciably above sea-level, it is necessary to correct for lowered boiling points of reagents and consequent reduced speeds of reaction. When Todd¹ estimated crude fibre in ten samples of plant materials at sea-level and at 6,200 ft., he calculated the percentage error involved in each instance and proposed three ways of correcting, namely: (1) by increasing the duration of the boiling; (2) by increasing the concentration of acid and alkali; (3) by carrying out the estimation by the standard procedure and applying a correction factor.

An examination of the first proposal was made by me in Nairobi, at an altitude of 5,700 ft. Twelve samples of plant material of varying fibre content were digested with 1.25 per cent acid and with 1.25 per cent alkali for periods of 15, 30, 45, 60, 90 and 180 min. Results showed that there is a highly significant inverse relationship between the logarithm of the time allowed for digestion and the resulting crude-fibre fraction of the material. In Nairobi, the reagents boil at 94.3° C., and a digestion period of 45 min. gives crude fibre values which do not differ significantly from those obtained by the conventional 30 min. digestion at sea-level: a calculated digestion period of 45.6 min. appears to give optimum correlation.

The following equation has been evolved to correct for lowered boiling points at higher altitudes by increasing the duration of the digestion period:

$$\text{time of digestion (min.)} = 30 \times 10^{(100 - t^\circ)/0.032}$$

where t° C. is the boiling point of the reagents.

Alternatively, the regression equation to correct the conventional 30 min. digestion value will be:

$$\text{crude fibre (corrected)} = \text{crude fibre (30 min. at } t^\circ) \times [1 - (100 - t^\circ) 0.0102]$$

H. W. DOUGALL

School of Agriculture,
King's College,
University of Durham.
Feb. 2.

¹ Todd, J. R., *Nature*, **168**, 76 (1951).

A Modified Method of Filter Paper Electrophoresis

In the course of our work on the separation of protein fractions from wheat gluten by means of paper electrophoresis, it was found that good resolution of hitherto unresolved fractions could be achieved by paper electrophoresis using long paper strips and high voltages over an extended period of time. This method does not require an organic cooling liquid, such as monochlorobenzene¹. It may be useful for the separation of enzyme mixtures, where contact with organic liquid may inactivate the enzymes.

In this method, the filter paper strip is wrapped, spiral fashion, around a glass tube, 22 in. long and $\frac{3}{8}$ in. external diameter, through which cold water is running (Fig. 1). To minimize evaporation from the strip, it is covered with a strip of thin 'Cellophane' of the same width. Humid conditions are maintained by enclosing a portion of the glass tube in a wooden box, which is lined with filter paper saturated with buffer. The ends of the filter paper, covered by 'Cellophane', pass in and out of the humid chamber by way of two narrow slits at the bottom, $\frac{3}{8}$ in. from each end. 'Cellophane' sleeves, attached to the chamber and terminating below the level of the buffer solutions, prevent the drying out of these portions of the strips.

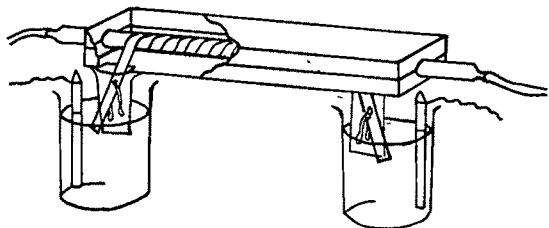


Fig. 1

Before use, the glass tube is treated with silicone grease. The filter paper strip is then passed through one sleeve, to which it is clamped with a paper clip, and wrapped tightly around the glass tube, passing out through the sleeve at the other end and clamped fast. To permit wrapping at an angle, the 'Cellophane' sleeves—through which the paper strips pass—are slit along the outside edge leaving a short uncut portion adjoining the box. At one end, together with the filter paper strip, a 'Cellophane' strip of the same width as the filter paper is clamped in. The point of application for the protein mixture is then marked on the paper and the buffer painted on with a brush. This procedure prevents tearing and bruising of the paper, which may occur when a buffer-moist, blotted strip is wrapped tightly around the glass tube. The substance is then applied to the marked line and the 'Cellophane' strip wrapped tightly so as to cover the whole length of the strip and to pass out through the second sleeve. The 'Cellophane' sleeves, filter paper and 'Cellophane' strip are then pierced and weighted with a piece of bent glass rod and the paper clips removed. The buffer vessels and the carbon electrodes are then placed in position below the chamber.

In our experiments, strips of Whatman 3MM paper, 60 cm. long and 2.5 cm. wide, were used. For a run of 24 hr. with a potential gradient of 9 V./cm., 2 x 2 litres of McIlvaine's buffer pH 2.07 and ionic strength of 0.025 were used. Unless high voltages are used (17 V./cm.), no condensation of water on the exposed surface of the glass tube takes

place; but even where this happens, loss of substance through migration off the paper rarely occurs. The 'Cellophane' covering the strip prevents the re-depositing of moisture on the filter paper. Protein spots obtained by this method are sharp and as well defined as spots obtained in electrophoresis between glass plates.

The full results of this investigation will be published elsewhere.

H. ZENTNER

Bread Research Institute of Australia,
111 Pacific Highway,
North Sydney, N.S.W. Jan. 6.

¹ Consden, R., *Nature*, 170, 1069 (1952).

Isolation of Fungi from Hyphae present in Soil

WHILE it is known that fungi may exist in soil both as active mycelium and as dormant spores¹, a major problem in the study of soil fungi has been to discover which fungi in a soil are present as mycelium. Plating methods by which fungal colonies are isolated from soil² or from soil suspensions³ on agar media suffer from the disadvantage that the unit of origin, spore or hypha, of the resulting colonies is not known. Direct microscopic examination, either of Rossi-Cholodny slides or soil films⁴, has the complementary deficiency that although fungal hyphae are seen, most are sterile and their identity cannot be investigated. I have devised a simple technique for the isolation of fungi directly from hyphae present in soil. Essentially the method depends on the observation that when a soil suspension is prepared, many of the fungal hyphae remain with the heavier soil particles of the residue. Removal of the fine suspended material from the residue also permits visual examination of the latter for the presence of individual hyphae or hyphal masses, which may then be removed and grown on agar media.

A soil crumb of about 1.0–1.5 gm. is placed in a beaker part-filled with water and left to become saturated. After 4–5 min. the crumb is broken apart by filling the beaker with a rapid jet of tap water. The heavier soil particles are allowed to sediment for 1.0–1.5 min. and then most of the suspension is poured off. Further water is added, the heavier particles allowed to sediment and the suspension again removed. This procedure is continued until the liquid remains clear after standing for 1.0–1.5 min. The soil particles of the residue are then distributed in a small quantity of water among three sterile Petri plates and searched for the presence of fungal hyphae using a binocular dissecting microscope ($\times 12.5$ and $\times 25$). Individual hyphae or portions of hyphal masses are removed with fine forceps from among the soil particles and are placed in a drop of sterile water on a clean sterile isolation plate.

Since many fungal hyphae isolated from soil are attached to mineral grains or to humus particles on or in which contaminating fungi and other micro-organisms may be present, it is desirable to remove as many as possible of these attached particles. Many may be removed by gently tapping the hypha against the bottom of the plate; others cannot be removed without killing the hyphae. Hyphal masses may also need to be teased out, since they usually consist of more than one species of fungus. When sufficient hyphae (usually 20–50) are on the plate, it is poured with melted but cooled agar and the hyphae

dispersed by shaking and rotating the plate before the agar solidifies. Hyphae are then located, ringed, and numbered on the reverse of the plate. Plates are incubated at room temperature and examined daily under a microscope ($\times 120$) for fungal growth.

Most hyphae show growth by the second or third day; some, however, show no definite growth until 7-9 days after preparation of the isolation plate. All clean hyphae showing growth are cut out in an agar block and transferred to fresh medium; sometimes hyphal tips only are removed. In many cases, particularly where humus particles are attached to a hypha, care is needed to be certain that the growth arises from the hypha and not from a humus particle. In these cases it is advantageous to remove the hypha in an agar block and examine it on a sterile slide at a higher magnification. If the origin of growth remains uncertain the block is discarded. It is also necessary to cut out any fungi developing from spores or humus particles on the isolation plates, to prevent them overgrowing ungerminated or slow-growing hyphae.

Several media have been investigated, the most useful of those tested being Dox+yeast agar (pH 5.6-5.8) diluted to one-sixth of its normal strength². Prerequisites for a good isolation medium are that it be transparent and that it prevents excessive growth of bacteria and Actinomycetes, particularly those that occur along the walls of the fungal hyphae. The addition of ammonium salts, of peptone, of soil extract, of hydrolysed casein, and of higher concentrations of yeast extract has stimulated the growth of some hyphae isolated from soil, but has encouraged increased growth of contaminating bacteria or Actinomycetes. The medium was not highly acidified, since it was noted that some hyphae were sensitive to low pH. Some hyphae isolated from soil, however, grew no further than 50-100 μ on the weak Dox+yeast agar or on any other medium tested.

This direct hyphal isolation method has proved useful in the isolation of the root pathogen *Rhizoctonia solani* from soil without the use of a host plant. This fungus has been isolated from many soils where its presence has been known from plant disease, and also from other soils where its presence was not suspected. The method, together with the dilution plate method, is also being used in a study of the ecology of the soil fungi occurring in a wheatfield at the Waite Institute, Adelaide. In this study some eighty species of fungi have been isolated by the direct hyphal method; by far the majority of them, even when shown to be abundant in soil as mycelium, were absent from dilution plates prepared from the same soil samples. The fungi isolated from hyphae fall into two broad groups: (a) fungi such as *Pythium*, *Rhizopus*, *Mortierella*, *Alternaria* and *Fusarium*, which are also frequent on dilution plates; (b) a large group of non-sporing fungi which are rare or absent from dilution plates. Several Basidiomycetes are included in this second group. These results indicate that the direct hyphal method isolates a large group of fungi that have hitherto been neglected in soil fungal studies. This work is continuing and will be published in detail elsewhere.

J. H. WARCUP

Waite Institute,
Adelaide. Jan. 10.

¹ Waksman, S. A., "Principles of Soil Microbiology" (Baillière, Tindall and Cox, London, 1927). Garrett, S. D., *Sci. Prog.*, 40, 438 (1952).

² Warcup, J. H., *Nature*, 166, 117 (1950).

³ Waksman, S. A., *Soil Sci.*, 58, 89 (1944).

⁴ Jones, P. C. T., and Mollison, J. E., *J. Gen. Microbiol.*, 2, 54 (1948).

Elminius modestus Darwin, a Northward Extension of Range

SINCE the discovery of the Australasian barnacle *Elminius modestus* Darwin in the south of England in 1945¹ (with further evidence of a previous settlement in 1943²), its rate of spread has been well documented³. It is therefore of interest to record the discovery of a single living specimen at Farland Point, Isle of Cumbrae, Scotland, on March 7, 1955. The nearest record to the present one, 55 miles south at Stranraer, Wigtownshire, was in 1950⁴.

The particular boulder to which it had attached, just above the level of low water of neap tides, has fortunately been under observation* for two years. It was completely bare of barnacles before the settlement of *Balanus balanoides* began in May 1954. The *Elminius* must therefore have become attached during the summer or autumn of 1954; its small size (3.5 mm. carino-rostral length) confirms this. A careful search of the immediate area and several other localities on the island has failed to produce another specimen.

JOSEPH H. CONNELL

Department of Zoology,
University of Glasgow.
March 18.

¹ Bishop, M. W. H., *Nature*, 159, 501 (1947).

² Stubbings, H. G., *Nature*, 166, 277 (1950).

³ Most of the relevant literature is cited in Bishop, M. W. H., *Nature*, 167, 531 (1951), and Kühl, H., *Helgoländ. Wiss. Meeresunters.*, 5, 53 (1954).

⁴ Crisp, D. J., and A. H. N. Molesworth, *Nature*, 167, 489 (1951).

A Chiton, *Callochiton fulvus* (Wood), in the River Fal

THERE is much recent evidence for the spread of marine organisms as fouling on ships' bottoms. *Crepidula fornicata* has been found in the River Fal, Cornwall, since 1947¹, usually in the vicinity of moored ships. An extensive oyster fishery exists in this estuary, and the dredgers and bailiff have been alive to the danger of the spread of *Crepidula*. This has resulted in a general interest in organisms other than oysters found during dredging. Recently, a large chiton was sent to me by Mr. P. P. Guy, the oyster bailiff. This proved to be *Callochiton fulvus* (Wood), the known distribution of which is Portugal, Spain and South America. This specimen was alive and attached to an oyster shell when caught; it had a length of 5.5 cm. It was taken in a dredge on the edge of the deep-water channel (3-4 fathoms) in Tolverne Reach, a stretch used for many years for mooring oil tankers while temporarily laid up.

It is known that other marine species from the Iberian coast live and grow in British waters. For example, Portuguese oysters (*Gryphaea angulata*) are imported and laid commercially in British estuaries, but water temperatures are rarely sufficiently high to promote spawning. Probably other southern forms have been and will be introduced, and may live in British waters for a while without becoming established.

The specific identification of the *C. fulvus* by Mr. S. L. Wilkins of the British Museum (Natural History) is acknowledged with thanks.

R. H. BAIRD

Fisheries Experiment Station,
Conway, North Wales. Jan. 20.

¹ Cole, H. A., *Fish. Invest.* Series II, 17, 7 (1952).

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Tuesday, May 31

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 6 p.m.—Prof. A. C. Frazer: "Studies on Intestinal Function in Man" (Almroth Wright Lecture).

Wednesday, June 1—Friday, June 3

IRON AND STEEL INSTITUTE, and the INSTITUTE OF METALS (jointly with the AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS and the AMERICAN SOCIETY FOR METALS), at Church House, Westminster, London, S.W.1—London sessions of the Joint Metallurgical Societies' meeting in Europe.

Wednesday, June 1—Saturday, June 11

BRITISH PLASTICS EXHIBITION AND CONVENTION (organized by British Plastics, Associated Iliffe Press, and the Plastics Institute, at Olympia, London, W.14).*

Thursday, June 2

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND (in the Henry Florence Hall of the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 2.30 p.m.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1), at 3 p.m.—Dr. C. E. K. Mees: "Leo Hendrik Baekeland and Photographic Printing Papers" (Baekeland Memorial Lecture).

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. H. C. Brown (Purdue University): "Chemical Effects of Steric Strains".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PROFESSOR OF THE ARCHEOLOGY OF THE ROMAN EMPIRE—The Registrar, University Registry, Oxford (June 2)

ASSISTANTS (2) IN MATHEMATICS—The Secretary, The University, Aberdeen (June 3).

WELLCOME VETERINARY RESEARCH FELLOWS for research in connexion with veterinary science or medicine—The Scientific Director, The Animal Health Trust, 14 Ashley Place, Westminster, London, W.1 (June 3).

ASSISTANT EXPERIMENTAL OFFICER IN THE GENETICS DEPARTMENT to be responsible for the maintenance of genetic stocks and to assist the Head of the Department—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (June 4)

ASSISTANT LECTURER, Grade A (with graduate qualifications and preferably some teaching experience), principally for teaching biology and some elementary chemistry, at the Municipal Technical College of Science and Art, Blackburn—Chief Education Officer, Education Offices, Library Street, Blackburn (June 4).

ASSISTANT (with a degree in chemistry or equivalent qualification and preferably with teaching and/or industrial experience) TO TEACH CHEMISTRY at the College for Further Education, Grimsby—The Director of Education, Education Office, Eleanor Street, Grimsby (June 4).

INORGANIC CHEMISTS AND PHYSICISTS, Assistant Experimental Officer grade (with G.C.E. (advanced level) in two scientific subjects or equivalent; if over 22 preferably with a pass degree, H.N.C. or equivalent) in the Department of Scientific and Industrial Research, Water Pollution Research Laboratory, Stevenage, Herts, for research on problems of polluted rivers and the treatment of polluting liquids—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.300/5A (June 4).

LECTURER (specially qualified to lecture on petrology and/or X-ray crystallography) IN GEOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (June 4).

LECTURER (with a degree in physics and suitable teaching experience) IN PHYSICS, and an ASSISTANT, Grade B (with a degree in physics and suitable teaching experience) IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (June 4).

LECTURER (with special interests in fluid mechanics) IN ENGINEERING, and a LECTURER (preferably with special interests in the theory of structures) IN CIVIL ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (June 4).

SCIENTIFIC OFFICER (preferably with previous research experience) IN THE CHEMISTRY DEPARTMENT, for work on the physical chemistry of soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 4).

SCIENTIST, Grade II (with a good honours degree or equivalent, with the main qualification in chemistry, and preferably with experience in the analysis of solid fuels) on the Staff of the Director of Scientific Control at London Headquarters, to maintain close liaison with scientists in the coalfields, and to deal with questions concerning the analysis of coal, mine air, etc.—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TTY/975 (June 4).

LECTURER (with an honours degree in physics, and preferably with industrial experience) IN PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan (June 6).

LECTURER (with particular interest in elasticity, structures or hydraulics) IN ENGINEERING (Civil)—The Registrar, The University, Manchester 13 (June 6).

SENIOR LECTURER or LECTURER IN ZOOLOGY, and a LECTURER IN EDUCATION at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (June 6).

MATHEMATICIAN (with a good honours degree in mathematics and a suitable qualification in statistics) IN THE AGRICULTURAL RESEARCH COUNCIL'S UNIT OF BIOMETRICAL GENETICS attached to the Department of Genetics, University of Birmingham—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (June 7).

ASSISTANT ANALYST (with a degree in science or agriculture) IN THE CHEMISTRY DEPARTMENT, West of Scotland Agricultural College, Auchincruive, near Ayr, for work mainly relating to the analysis of agricultural materials other than soils—The Secretary, West of Scotland Agricultural College, 6 Rlythwood Square, Glasgow, C.2 (June 8).

LECTURER IN GREEK ARCHEOLOGY AND ANCIENT HISTORY—The Registrar, King's College, Newcastle-upon-Tyne (June 11).

ASSISTANT LECTURER (Grade II) or DEMONSTRATOR IN PHYSIOLOGY—The Registrar and Secretary, The University, Bristol (June 13).

ASSISTANT LECTURER (with special qualifications in mineralogy and petrology) IN THE DEPARTMENT OF GEOLOGY—The Registrar, The University, Leeds 2 (June 13).

DEMONSTRATOR IN CHEMICAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (June 13).

LECTURER (with an honours degree in civil engineering and practical experience) IN CIVIL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (June 13).

LECTURERS (2) IN THE DEPARTMENT OF PHYSIOLOGY, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 13).

CHAIR OF MATHEMATICS at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 15).

LECTURER IN EDUCATION—The Registrar, The University, Nottingham (June 15).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY, a LECTURER (preferably with experience in machine design) IN MECHANICAL ENGINEERING, a LECTURER IN ZOOLOGY, and a LECTURER (with special interests in applied mathematics) IN MATHEMATICS, at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 15).

LECTURER IN VETERINARY HISTOLOGY AND EMBRYOLOGY, and a LECTURER IN ANIMAL HUSBANDRY AND PREVENTIVE MEDICINE—The Secretary of University Court, The University, Glasgow (June 16).

PROFESSOR OF MATHEMATICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 15).

CHEMIST (with either a pass degree or higher national certificate in chemistry) for the mineral analysis of plant materials—The Secretary, East Malling Research Station, near Maidstone, Kent (June 18).

RESEARCH OFFICER (with a university honours degree, with special training and/or research experience applicable to the study of soil fertility problems), at Kimberley Research Station, Land Research and Regional Survey Section, W. Australia, for field and laboratory investigations into problems of soil fertility with tropical crops and pastures grown under irrigation—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (June 18).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university honours degree in science or in veterinary science) IN THE DIVISION OF ANIMAL HEALTH AND PRODUCTION, Prospect, N.S.W., Australia, for investigations of digestion in ruminants—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 205/69 (June 18).

CHAIR OF INORGANIC AND PHYSICAL CHEMISTRY, and a LECTURER IN CHEMISTRY, at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, June 30).

LECTURER IN MATHEMATICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

ASSISTANT (with at least a good honours degree in zoology and preferably with qualifications in entomology) IN ZOOLOGY—Joint Clerk to the University Court, Queen's College, Dundee (July 31).

LECTURER IN CHEMISTRY—The Registrar, Hatfield Technical College, Roe Green, Hatfield, Herts.

LECTURER IN INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham 15.

LECTURER (with a university degree in agriculture and some teaching experience) IN AGRICULTURE, at the College of Agriculture, Mauritius—The Director of Recruitment, Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BOD.63/52/06.

PHYSICIST (basic grade) (with an honours degree and research experience, and preferably with experience in a hospital physics department) IN THE DEPARTMENT OF RADIOTHERAPY (Physics)—The House Governor, Queen Elizabeth Hospital, Birmingham.

PROFESSOR OF MATHEMATICS, a PROFESSOR OF PHYSICAL CHEMISTRY, a PROFESSOR OF CHEMICAL ENGINEERING, and a PROFESSOR OF APPLIED BIOLOGY, at the Israel Institute of Technology, Haifa, Israel—The Secretary, The Technion Society of Great Britain, 83 Wimpole Street, London, W.1.

READER and SENIOR LECTURERS or LECTURERS IN CHEMISTRY—The Dean, College of Arts and Science, Baghdad, Iraq.

RESEARCH ASSISTANTS (2) IN THE DEPARTMENT OF MATHEMATICS AND PHYSICS, for research in the field of vacuum physics and ultrasonics—Head of the Department of Mathematics and Physics, The Polytechnic, 309 Regent Street, London, W.1.

SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (honours graduates in physics or chemistry) for work which covers a wide range of problems connected with the manufacture and use of ceramic materials—The Director of Research, British Ceramic Research Association, Queens Road, Penkhill, Stoke-on-Trent.

SENIOR LECTURER IN METALLURGY, an ASSISTANT LECTURER (Grade B) IN ELECTRICAL ENGINEERING, an ASSISTANT LECTURER (Grade A) IN STRUCTURAL ENGINEERING, and an ASSISTANT LECTURER (Grade A) IN PHYSICS, at Constantine Technical College, Middlesbrough—The Director of Education, Woodlands Road, Middlesbrough.

SENIOR RESEARCH ASSISTANT (with a good honours degree in engineering, practical experience and/or research training) IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

TECHNICIAN (preferably with experience in a laboratory workshop and/or in pharmaceutical or chemical laboratories) IN THE PHARMACY DEPARTMENT—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Russian Comfrey Report No. 1: The 1954 Research Results. By Lawrence D. Hills. Pp. ii+86+5 plates. (Bramtree: Henry Doubleday Research Association, 1955.) 3s. [153]

British Institute of Management. The Recruitment and Training of Men Intended for Management Positions. Pp. 70. (London: British Institute of Management, 1955.) 5s. [153]

Pitt Rivers Museum: University of Oxford. Hair Embroidery in Siberia and North America. By Geoffrey Turner. (Occasional Papers on Technology—7. Edited by T. K. Penniman and B. M. Blackwood.) Pp. 83+16 plates. (Oxford: Pitt Rivers Museum, University of Oxford, 1955.) 15s. [153]

Annual Report of the National Oceanographic Council, 1 April 1953—31 March 1954. Pp. v+28. (Cambridge: At the University Press, 1955.) 5s. net. [153]

Institution of the Rubber Industry. Annual Report on the Progress of Rubber Technology. Vol. 18: 1954. Pp. ix+188. (Cambridge: W. Heffer and Sons, Ltd., 1955. Published for the Institution of the Rubber Industry.) 21s. [153]

Metropolitan Water Board. Report on the Results of the Bacteriological, Chemical and Biological Examination of the London Waters for the years 1947-1952. By Lt.-Col. E. F. W. Mackenzie. (Thirty-fifth Report.) Pp. 118+2 plates. (London: Staples Press, Ltd., 1955.) 15s. 6d. [153]

Proceedings of the University of Durham Philosophical Society. Vol. 12, No. 4: Observations on the Vascular Plants of the Outer Hebrides made in 1954. By Dr. J. W. Heslop Harrison. Pp. 29-34. Vol. 12, No. 5: Further Investigations in the Flora of the Magnesian Limestone Area of Durham. By Dr. J. W. Heslop Harrison and J. A. Richardson. Pp. 35-42. (Durham: University of Durham Philosophical Society, 1954.) [153]

Proceedings of the British Weed Control Conference 1954, Hotel Majestic, Harrogate, November 2nd, 3rd, and 4th, 1954. Pp. x+624. (London: Association of British Insecticide Manufacturers, 86 Strand, 1955.) 30s. [233]

Aero Research Technical Notes. Bulletin No. 146 (February, 1955): "Redux" and the Comet Enquiry. Pp. 3. (Duxford: Aero Research, Limited, 1955.) [233]

Scientific Journal of the Royal College of Science—Vol. 24, containing papers read before the Imperial College Chemical Society; the Royal College of Science Natural History Society; the Royal College of Science Mathematical and Physical Society. Pp. vi+122. (London: Royal College of Science, 1954.) 10s. 6d. [233]

Department of Scientific and Industrial Research. Road Research Laboratory. Road Research Technical Paper No. 34: Testing Concrete by an Ultrasonic Pulse Technique. By Dr. R. Jones and E. N. Gatfield. Pp. vi+48+2 plates. (London: H.M. Stationery Office, 1955.) 2s. 6d. net. [233]

Southern Regional Council for Further Education. Sandwich Training and Education—Report on addresses by Sir Arthur J. G. Smout, and Mr. J. Wilson, 14th October, 1954, at the Conference Room, Civic Centre, Southampton. Pp. 15. (Reading: Southern Regional Council for Further Education, 1954.) [233]

Royal Institute of Chemistry. Annual Report of the Council for 1954. Pp. 28. (London: Royal Institute of Chemistry, 1955.) [233]

Observations made at the Royal Observatory, Greenwich, in the year 1941, in Astronomy, Magnetism and Meteorology, under the direction of Sir Harold Spencer Jones. Pp. vi+258. (London: H.M. Stationery Office, 1954.) 70s. net. [233]

Ministry of Agriculture and Fisheries. Memoirs of the Soil Survey of Great Britain. England and Wales. The Soils of the Glastonbury District of Somerset (Sheet 296). By B. W. Avery. Pp. iv+131+4 plates. (London: H.M. Stationery Office, 1955.) 15s. net. [253]

William Ramsay Centenary Appeal: the Report of the Trustees, 1955. Pp. 28. (London: University College, London, 1955.) [253]

Oundle School Natural History Society. Annual Report, 1954. Pp. ii+64. (Oundle: Oundle School Natural History Society, 1955.) [253]

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 932, Vol. 247 (24 March 1955): The Structure of Some Proteins as Revealed by an X-ray Scattering Method. By U. W. Arndt and D. P. Riler. Pp. 409-439. 10s. No. 933, Vol. 247 (24 March 1955): The Thermal Conductivity of Metals at Low Temperatures. By H. M. Rosenberg. Pp. 441-497. 18s. (London: Royal Society, 1955.) [253]

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 1, Vol. 5, No. 8: Movements of Salmon off the North-East Coast of England. By W. G. Hartley and J. D. Brayshaw. Pp. 17. (London: H.M. Stationery Office, 1955.) 3s. 6d. net. [293]

Anti-Locust Research Centre. Anti-Locust Bulletin No. 19: A Laboratory Study of Roosting Behaviour in Hoppers of the African Migratory Locust (*Locusta migratoria migratorides* R. & F.). By Dr. R. F. Chapman. Pp. 21+40. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1955.) 4s. 6d. [293]

Macaulay Institute for Soil Research. Annual Report, 1953-1954. Pp. 55+2 plates. (Craigiebuckler, Aberdeen: Macaulay Institute for Soil Research, 1955.) [293]

City and Guilds of London Institute. Annual Report of the Council 1st October, 1953, to 30th September, 1954. Pp. 47+xvii. (London: City and Guilds of London Institute, 1955.) [293]

Veterinary Clinical Studies at Cambridge. By Prof. L. P. Pugh (Inaugural Lecture given at Cambridge, 8 March 1955.) Pp. i+26. (Cambridge: At the University Press, 1955.) 2s. 6d. [293]

Everest: A Guide to the Climb. (Chart.) By James Champior (London: University of London Press, 1955.) 1s. 6d. [31]

Scottish Marine Biological Association. Collected Reprints, 195- (Nos. 148-184). (Millport, Isle of Cumbrae: Scottish Marine Biologist Association, 1955.) [31]

British Journal Photographic Almanac, 1955. (Ninety-sixth year of publication.) Edited by Arthur J. Dalladay. Pp. i+640+8 plates. (London: Henry Greenwood and Co., 1955.) 5s. net (Linsol board covers); 7s. 6d. net (Cloth bound). [31]

The Year's Photography, 1955. (Reviews of Photographical Art-Photographic Science and Applied Photography, with a Selection of Pictures from the Exhibitions held in the Society's House during the past year.) Pp. 19+82 plates+xii. (London: Royal Photographic Society, 1955.) 7s. 6d. [31]

Wool Industries Research Association. Report of the Director of Research for 1954-55. (W.I.R.A. Publication No. 201.) Pp. 31. (Leeds: Wool Industries Research Association, 1955.) [31]

Other Countries

Mitteilungen des Deutschen Wetterdienstes. No. 10 (February, 1955): Die Synoptiker-Tagung in Frankfurt a.M. vom 1. bis 9. November 1954. Pp. 118. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) [153]

Administration Report of the Government Museum, Madras; the National Art Gallery, Madras; the Government Museum, Pudukkottai; and the Connemara Public Library (Exchange Section) Madras, for 1953-54. Pp. 38+2 plates. (Madras: Government Press, 1954.) [183]

Federation of Nigeria. Annual Report of the Department of Agriculture (Central) for the year 1952-53. Part 1: Pp. 15. 9d. net. Part 2: Pp. 47. 9d. net. (Lagos: Federal Government Press, London: Crown Agents for Oversea Governments and Administrations, 1955.) [183]

Council of Scientific and Industrial Research, New Delhi. Engineering Research in India. By V. Cadambe. Pp. x+114. (New Delhi: Council of Scientific and Industrial Research, 1954.) [183]

Colony and Protectorate of Kenya. Report of the Forest Department for the years 1951, 1952, 1953. Pp. ii+71. (Nairobi: Government Printer, 1954.) Sh. 4. [233]

Seventh Annual Report of the Pacific Marine Fisheries Commission for the year 1954. Pp. 20. (Portland, Oregon: Pacific Marine Fisheries Commission, 1955.) [233]

International Scientific Radio Union. Special Report No. 4: The Distribution of Radio Brightness on the Solar Disk. Special Report No. 5: Interstellar Hydrogen. Pp. 72. (Brussels: International Scientific Radio Union, 1954.) [233]

Canada. Department of Agriculture. Science Service—Division of Forest Biology. Forest Lepidoptera of Southern Ontario and Their Parasites Received and Reared at the Ottawa Forest Insect Survey Laboratory from 1937-1948. By Henri Raizenne. Pp. iv+258. (Ottawa: Department of Agriculture, 1952.) [233]

Indian Central Jute Committee. Annual Report of the Jute Agricultural Research Institute (1953-54). Pp. 145. (Calcutta: Indian Central Jute Committee, 1955.) [253]

Journal of Biophysical and Biochemical Cology. Vol. 1, No. 1 (January 25, 1955). Published Bimonthly. Annual Subscription 7.50 dollars; Single issues 1.50 dollars. (Baltimore, Md.: Rockefeller Institute for Medical Research, 1955.) [253]

Smithsonian Miscellaneous Collections. Vol. 128, No. 2: Washington, D.C. Precipitation of 1954 and 1955. By C. G. Abbot. Pp. 3. (Publication 4210.) (Washington, D.C.: Smithsonian Institution, 1955.) [253]

Kungl. Svenska Vetenskapsakademien. Handlingar. Fjärde Serien, Band 5, Nr. 3: Maps of a Selection of Scandinavian Hieracium Species. By Gunnar Samuelsson. Edited by Erik Almqvist. Pp. 10+123 maps. (Stockholm: Almqvist and Wiksells Boktryckeri AB, London: H. K. Lewis and Co., Ltd., 1954.) 20.60 kronor. [253]

Československá Akademie Věd: Academia Scientiarum Bohemoslovenica. Folia Biologica. Tomus 1, Fasciculus 1. (February 1955). Pp. 64+8 plates. Yearly subscription (6 numbers) 60 Kčs. Single issues 10 Kčs. (Praha: Biologický ústav CSAV. Orders to "Artia," Smeky 80, Praha 2, 1955.) [293]

Union of South Africa. Department of Education, Arts and Science. Report of the Archaeological Survey of the Union of South Africa for the period 1st April, 1953, to 31st March, 1954. (Annual Report No. 19.) Pp. ii+5. (Pretoria: Government Printer, 1954.) [293]

Joint Establishment for Nuclear Energy Research. Third Annual Report, 1953/54. Pp. iii+28. (Kjeller near Lillestrøm: Joint Establishment for Nuclear Energy Research, 1955.) [293]

World Health Organization. Monograph Series No. 26: Poliomyelitis. Contributed by Robert Debré, Darline Duncan, John F. Enders, Matthieu-Jean Freyche, Sven Gard, James Gear, W. McD. Hammon, Hilary Koprowski, H. C. A. Lassen, Johannes Nielsen, John R. Paul, A. M. M. Payne, A. J. Rhodes, W. Ritchie Russell, A. B. Sabin, Stéphane Thiefry and W. Wood. Pp. 408. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 24 Swiss francs; 40s.; 8 dollars. [313]

New Zealand. Department of Scientific and Industrial Research—Geophysics Division. Amberley Observatory. Magnetic Results for 1952. Pp. iii+86. (Wellington: Government Printer, 1954.) [313]

United States Department of Commerce: Weather Bureau. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12, and 24 Hours. Part 10. New York. Pp. ii+113. (Washington, D.C.: Government Printing Office, 1954.) 60 cents. [313]

NATURE

No. 4466

SATURDAY, JUNE 4, 1955

Vol. 175

CONTENTS

	Page
Government Research in Britain	957
Importance of Porphyrins in Medicine. By Dr. A. Neuberger, F.R.S.	959
Psychology and Mythology. By Prof. C. A. Mace	960
Chemical Specificity in Biological Interactions. By Dr. H. Gutfreund	960
Ion-solvent Interaction in Solutions. By Prof. C. W. Davies	961
The Meteorological Office, 1855-1955. By Sir Graham Sutton, C.B.E., F.R.S.	963
The Government Laboratory Polonium Service	965
Department of Scientific and Industrial Research: Report for 1953-54	965
The Paint Research Station, Teddington: Open Days. By W. D. R.	969
Zoological Society of London: Exhibition of Whales and Whaling. By Dr. L. Harrison Matthews, F.R.S.	970
Observations on Heavy Mesons and Hyperons	971
The Exposure of the Piltdown Forgery. By Sir Wilfrid Le Gros Clark, F.R.S.	973
Obituaries:	
Dr. Thomas Royds. By Prof. F. J. M. Stratton, O.B.E., F.R.S.	974
Dr. G. H. Miles. By Alec Rodger	974
News and Views	975
Aero Research, Ltd.: Twenty-first Anniversary	980
Fatigue in Metals. By Dr. J. W. Christian	980
Aromatic Substitution. By Dr. M. F. Ansell and Prof. M. J. S. Dewar	982
Soil Zoology: Easter School at Nottingham. By O. Gilbert and J. Hobart	983
A Conditioning Laboratory for the Investigation of Personality and Cortical Functioning. By Dr. C. M. Franks	984
The Water Supply of London	985
<i>Ageratum houstonianum</i> as a Test Object for Growth-Substances	986
Red Lechwe and Chinese Sika	986
Fisheries Research in Hong Kong. By Dr. G. A. Steven	987
Anaphylatoxin, Histamine Depletion and Skin Reactions in the Rat. By Dr. M. Rocha e Silva and A. M. Rothschild	987
Use of Solubilizing Agents in Gas-phase Partition Chromatography. By J. H. Purnell and M. S. Spencer	988
Letters to the Editors:	
Relation of Leuco-anthocyanins to Anthocyanin Synthesis.—R. E. Alston and Dr. C. W. Hagen, jun.	990
Nature of a Hemicellulose extracted from Cellulose with Water.—G. W. Huffman, P. A. Rebers, D. R. Spiersbach and Prof. F. Smith	990
A New Type of Copolymer.—D. A. Barr and Dr. R. N. Haszeldine	991
Dimerization Reactions in Sunlight.—Dr. Ahmed Mustafa	992
Inactivation of Phage due to Assimilated Phosphorus-32 and the Recovery of Host Cells.—Dr. C. Castagnoli, P. Donini and F. Graziosi	992
Occurrence of Acid Phosphatase in Association with the Haustoria of Powdery Mildew on Barley.—T. G. Atkinson and Prof. M. Shaw	993
Formation of 5-Hydroxytryptophan from Tryptophan by <i>Chromobacterium violaceum</i> .—Chozo Mitoma, Herbert Weissbach and Sidney Udenfriend	994
Effect of Deoxycorticosterone on the Reticulo-Endothelial System.—Prof. T. Nicol and R. S. Snell	995
Binocular Vision and Deep-Sea Fish.—Dr. R. A. Weale	996
Euphausiopsin, a New Photosensitive Pigment from the Eyes of Euphausiid Crustaceans.—Elizabeth M. Kampa	996
Depression in Brain Potassium in Ovine Pregnancy Toxaemia.—B. P. Setchell and G. L. McClymont	998
<i>Brucella abortus</i> Strain 19 cultivated in Aerated Liquid Medium.—Dr. G. C. van Drimmelen	999
Production of Plaques with Influenza Viruses.—Dr. Nada Ledinko	999
Elephant Seal Cow and Pup on South African Coast.—Dr. H. B. D. Kettlewell and Dr. B. Rand	1000
Production of Abnormal Metamorphosis in a Tunicate.—Dr. L. G. E. Bell	1001
Chromaffin Tissue in the Lizard Adrenal Gland.—A. Wright and I. Chester Jones	1001
Emergence of the Sporoplasm in <i>Nosema helminthorum</i> .—A. S. Dissanaika	1002
Uses of the Globe Photometer.—Dr. W. R. G. Atkins, O.B.E., F.R.S., and Dr. H. H. Poole	1003
Rotational Analysis of the Tantalum Oxide Bands.—D. Premaswarup	1003
Origin and Age of Meteorites.—Prof. F. A. Paneth, F.R.S., G. R. Martin and Dr. S. J. Thompson	1003
"Applied Statistics."—Dr. D. A. Bell; F. Downton	1004
An Amplifier based on the Hall Effect.—Prof. H. M. Barlow; J. M. Ross and N. A. C. Thompson	1004

H. K. LEWIS & Co. Ltd.

★ STATIONERY DEPARTMENT ★

A Comprehensive range of Sectional Designers' Papers, Graph Books and Pads. Sheets and Pads of Logarithmic—"Z" Charts—Circular Percentage—Reciprocal—Probability—Binomial—Logistic—Log Logistic—Triple Co-ordinate—Polar Graph—Impedance Charts—Time Table (Gantt)—Daily, Weekly, and Monthly Charts, etc., held in stock.

Catalogues sent on application

H. K. LEWIS & Co. Ltd., 136 Gower Street
Telephone] LONDON, W.C.1 [EUSton 4282

The SCIENTIFIC BOOK SUPPLY SERVICE (T. FREDERICK DE LOCHE)

LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American,
Colonial & Foreign Libraries

Specialists in
Scientific Books &
Periodicals

PHONE: CEN. 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

We Export for Dollars.

Wm. DAWSON & SONS, Ltd.

*World's Largest Stockists
of Scientific Periodicals*

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading
Universities, Public Libraries
and Institutions of the World.
Catalogues issued.

SELLING?

Specialists in Scientific,
Technical Books and
Publications of all
Learned Societies.

Why not consult us first?

4 DUKE STREET, MANCHESTER SQUARE,
LONDON, W.1

M. G. KENDALL, Sc.D.

Professor of Statistics, University of London

A revised and enlarged edition

RANK CORRELATION METHODS

CONTENTS: Measurement of rank correlation—Introduction to general theory—Tied ranks—Tests of significance (and proof of results)—Problem of m rankings (and proof of results)—Partial rank correlation—Ranks and variate values (and proof of results)—Paired comparisons (and proof of results)—Some further applications—References—Appendix tables (Ten in number)—Index

SECOND EDITION Price 36s. net

CHARLES GRIFFIN & CO., LTD.
DRURY LANE LONDON, WC2

PRECISION



INSTRUMENTS

Immersion Refractometer and Water Bath

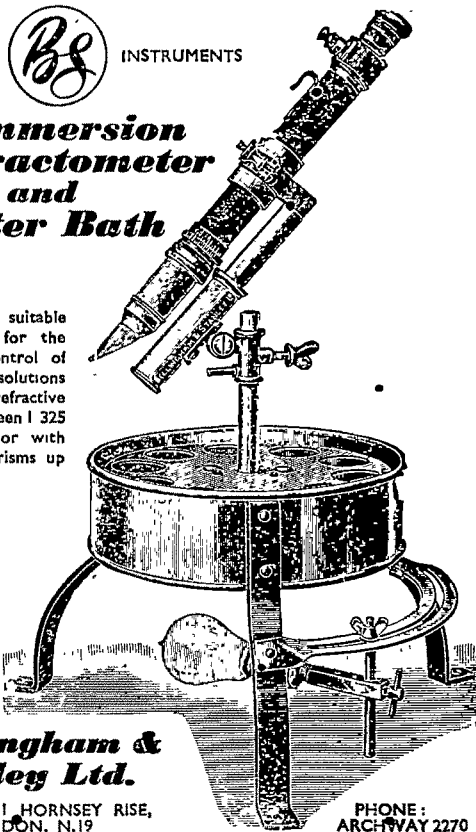
The most suitable
instrument for the
accurate control of
strengths of solutions
having refractive
indices between 1.325
and 1.367, or with
additional prisms up
to 1.5

Full
particulars
from the
makers

**Bellingham &
Stanley Ltd.**

DEPT. N, 71 HORNSEY RISE,
LONDON, N.19

PHONE:
ARCHWAY 2270



GOVERNMENT RESEARCH IN BRITAIN

THE report of the Advisory Council for Scientific and Industrial Research for 1953-54 (see p. 965 of this issue) reveals clearly how slender is the real expansion in the work of the Department of Scientific and Industrial Research that will be possible through the programme outlined in the House of Commons on December 8, 1953. Of the increase of £578,379 for 1954-55 compared with 1953-54, more than £300,000 represents an increase in the contribution to the European Organization for Nuclear Research; of the increase of £260,000 in the Department's net vote for 1955-56, a further £160,000 goes for the same purpose. Even a slight increase in running costs or in salaries thus means that at best the increased vote will enable the Department to maintain its activities at the current level, and that there will be no provision for overall expansion.

This does not, of course, mean that some of the Department's work will not be expanded, even if that involves the curtailment of other activities; indeed, the most important and encouraging feature of the present report is the evidence it affords that the Advisory Council is reviewing the whole work of the Department and that under the terms of the statement made on December 8, 1953, such review and planning can proceed on a quinquennial and not a year-to-year basis. Within the limits of its present resources, the work of the Department is now clearly being carried out more effectively in relation to national needs and without the waste of effort and resources involved in snap decisions on an annual basis. The Advisory Council, in fact, regarded as its most important tasks in the year under review the study of the needs of the various branches of the Department's work in the light of the conditions of to-day, and advice where the increased effort available is most urgently needed.

In particular, a rapid decision on the distribution of the proposed increases of about 150 non-industrial staff per annum, with about one-third that number of industrial staff, as they become available, was imperative. Since the post-war plans outlined in 1948 were formulated, new needs have arisen. The Advisory Council therefore does not take the view that, since adequate resources will be available to cover some 95 per cent of the activities projected in that plan, this implies that those resources are to be distributed rigidly in accordance with the details of the plan. Rightly it is attempting to re-assess the problems confronting the Department as a whole, and to allocate resources in the light of the circumstances of to-day. There is some evidence in this report that it is also guided by the view that the Department's activities in general should not be strictly limited to those which are considered appropriate to a Government organization, but should also be extended to cover work best carried out in that way or unlikely otherwise to be carried out at all. In particular, the revised terms of grant to the research associations, while designed to encourage the expansion of that work, are equally designed to

require more substantial effort from the industries served by the research associations.

The interim decision on distribution of the additional non-industrial staff, reached in January 1954 with the help of a preliminary survey of current objectives and distribution of effort, allocated rather more than 100 of the 150 to be available by April 1, 1955, between the Mechanical Engineering Research Laboratory, the Road Research Laboratory, the Water Pollution Research Laboratory, the Hydraulics Research Station and the Fuel Research Station. By July, however, a more detailed analysis of the Department's current programmes and objectives was available; and the Advisory Council is making further recommendations for the distribution of the extra staff to become available during the remaining four years in the light of this analysis and its own further experience, which, during the year, was concerned mainly with fourteen establishments, three of which were visited corporately. Nevertheless, the Advisory Council found it no easy task to assess quantitatively the importance of the work of one of the Department's establishments as against another. A quantitative basis for a decision, for example, to expand pest infestation research rather than water pollution research or *vice versa*, is hard to find, though the Council has no hesitation in saying that, at present, there is no establishment in the Department to which considerably greater resources could not, with profit, be assigned.

The Advisory Council, however, is not only conscious of the desirability of relating the Department's activities to proved rational needs and to those which are appropriately met by a government establishment rather than by industry itself or a private or independent research institution: it is equally conscious that limits to its recommendations are set by the man-power situation, as well as by the financial resources which Parliament puts at its disposal. Indeed, quite as encouraging as the indication that the Advisory Council is now able to plan its activities over a term of years, instead of from year to year, and that it is closely scrutinizing those activities in relation to national needs, is the evidence that such investigation and planning are also carried out in full consciousness of the vital claims of the universities and schools as well as of industry to available resources of scientific man-power. Specifically it welcomes the survey of the distribution of graduates between industrial, academic and other posts which Political and Economic Planning is carrying out. It recognizes that the shortage of scientists sets its own limit, and the Council is not attempting to claim more than a fair share of scientific man-power for the Department's activities. Whether the claim is excessive or too modest is not for the Advisory Council to say. It is one on which the Advisory Council for Scientific Policy might well be expected to comment, and the main responsibility for decision lies with the Lord President of the Council, to which the Council's report is submitted.

Leaving, therefore, the question whether or not the Advisory Council is right to accept the five-year proposals as a reasonable current assessment of the share of Government expenditure and of the country's scientific man-power to be devoted to the work of the Department, some comments of the Advisory Council on the scale of particular activities should be noted. Attention has already been directed to the high proportion of the additional funds which will be absorbed by the European Organization for Nuclear Research. Besides this, the Department is contributing about £300,000 a year in support of nuclear research in universities, so that out of the Department's £6½ million in 1954-55, some £650,000, and out of its £6·5 million for 1955-56, more than £800,000, goes for research in this one field. Beyond indicating the constitution of a full committee of its Scientific Grants Committee to consider all applications for grants for research in this field and to keep under review all the scientific aspects of the Department's responsibilities here, the Advisory Council makes no comment on this situation. Whether the proportion of effort in nuclear physics is excessive cannot be judged from this report; but this high proportion of effort in a single field should be remembered in the context that no account is taken of the demands represented in the £50 million voted for the Atomic Energy Corporation, and that even the latter amount does not include man-power or finance and materials which are expended in nuclear physics for defence purposes.

That is obviously a situation that demands consideration at a high level, and while public discussion of all its aspects may be undesirable for security reasons, this in itself is a reason for insisting that the Lord President should take every care to make it manifest that he is adequately provided with scientific advisers whose quality commands confidence, and that their advice is effectively rendered and disseminated. Something appears to have been done recently in this direction so far as the Minister of Defence is concerned; but the position remains unsatisfactory in regard to the Lord President of the Council, both *vis-à-vis* Parliament itself and the several research councils and other scientific bodies. This is perhaps a matter which the Parliamentary and Scientific Committee could with advantage pursue.

On building research, the Advisory Council expresses the opinion that the Building Research Station has been instrumental in introducing marked improvements into building practice, often pointing the way simultaneously to better quality and to economy in effort and materials. It believes that there is widespread and growing appreciation of the Station's work among government departments, among professional men and all branches of the building industry in Britain. The first major expansion in the Department to meet post-war needs was made for building research, while, in 1950, the Chief Scientific Adviser's Division of the Ministry of Works, which is concerned with the study of the economic, sociological and productivity aspects of the building industries, was transferred to the Department. Although the proportion of the Department's

resources devoted to building research has since been reduced, the non-industrial staff of the Station is still about 14 per cent of the total for all the establishments.

The Advisory Council has no doubt that there is justification for extending research on building, and hopes there will be even further expansion. Rightly it points out that the staff cannot be expected to continue to increase at government expense, proportionately to the total increase in the Department as a whole. It suggests, therefore, that any substantial increase in the resources for building research, within the Department, or elsewhere, must be sought outside the Department; and it makes the pertinent comment that the building industry as a whole does not appear to make so large a contribution to research for its own benefit as do most industries, and as it might do.

The Advisory Council, in this connexion, welcomes a recent arrangement by which the National Federation of Building Trade Employers has agreed to provide means for the full-scale trials of the results of certain studies at the Building Research Station; and it suggests that larger firms, or collective bodies, in the industry might create research studentships or fellowships tenable at the Station, or send to the Station, for research apprenticeships as it were, young men whom they proposed to take on to their own staffs. What the situation seems to demand is some such survey of the industry and its research organization as has been carried out already in respect of a few research associations. The Advisory Council makes no such recommendation, though an independent survey might well produce some forthright as well as constructive comment, not merely on the research attitude of the industry, but also on the decision to discontinue operational research; and on such ventures as the creation of the Scottish Laboratory, which almost inevitably would seem to entail some duplication of Government effort that more co-operation and enterprise on the part of the industry in Scotland would obviate.

The Mechanical Engineering Research Laboratory is another field in which the Advisory Council sees limits to expansion on the present rapid scale. The recruitment of non-industrial staff authorized for the year under review brings the total of such staff to some 7 per cent of the Department's total, and the total at least will grow over the next few years as new buildings become available. While the Council is impressed by the importance of the work in progress and is satisfied that the Laboratory will make valuable contributions to the scientific and technical knowledge essential for the continued efficiency of the engineering and allied industries, it indicates that the needs will in future have to be weighed against those of other branches of the Department's work.

The Advisory Council is specially concerned at present to promote the work of the Fuel Research Station and the Road Research Laboratory. In the thirty-five years since the former was established, its position and outlook have been altered by the formation of various research associations, like the British Coal Utilization Research Association, by the

increased interest taken in fuel research by other industrial organisations, by the research responsibilities laid upon the new nationalized industries in their specific fields and by the responsibility vested in the Ministry of Fuel and Power "for the co-ordinated development of all sources of fuel and power and for promoting their economical and efficient use". While the Fuel Research Board has kept the programme of the Station constantly under review in the light of these developments, and with particular regard to the transfer of appropriate sections of the Station's work, the demands on the Fuel Research Station remain heavy and difficult to meet satisfactorily. More staff and rapid provision of a new research station have become imperative. The Advisory Council has sanctioned an immediate increase in staff to accelerate work on atmospheric pollution and domestic heating, and the planning of a new station is being considered in the context that it is still necessary for the Station to maintain its position as a national centre for the study of fuel problems.

Priority in the distribution of the increased resources available to the Department in the year under review has also been given to the Road Research Laboratory, on which the Advisory Council is convinced that more money could be spent to advantage. The provision now being made for a new station, on a much larger site at Crowthorne, Bucks, includes, as a first step, space for a much-needed experimental road circuit, which is being constructed in advance of the general building of the new station.

Two further matters in the Advisory Council's report call for comment. Under the heading "Human Factors in Industry", the Advisory Council refers to programmes of research in the social sciences which the Department has sponsored jointly with the Medical Research Council, and largely with the support of Conditional Aid Counterpart Funds. This work is mainly concerned with problems of management and of human relations arising from technological change. Like that on production economics, also largely supported from Conditional Aid Counterpart Funds, it bears closely on industrial efficiency and is also concerned with the dissemination of information with which the new section of the Intelligence Division—the Industrial Operations Unit—of the Department is likewise engaged.

There is no indication in the "Summary of Expenditure" of the extent to which the Department's resources are committed to this new field which, as the Advisory Council recognizes, is outside those of natural science and technology, with which the Department has been predominantly concerned in the past. Without questioning the value and importance of such programmes to industrial progress, it should be recognized that there is here a trend which, apart from its somewhat dubious dependence upon Counterpart Funds, could lead to the real magnitude of the Department's contribution to scientific and industrial research being somewhat masked. There is no *prima facie* purpose in mixing expenditure on sociological research with that on scientific and technological research in the usually

accepted sense, however significant may be the contribution that sociological research may make to industrial development.

Although the amounts at present involved appear to be small, it is important that confusion should be avoided from the start, and much the same applies to the second matter calling for comment. From its inception, the Department has had a close interest in the training of research workers, through its system of research awards and maintenance allowances. In recent years the educational functions of the research associations have become of increasing importance, and resulted, in the period covered by the report, in a conference on November 27, 1953, to discuss the part such research associations could play in advancing technological and technical education. The Advisory Council recognizes the importance and value of this function, and its report indicates that the Department is exploring other possibilities of improving postgraduate instruction to meet the requirements of industry.

Nevertheless, here again the danger exists that a considerable and unknown proportion of the Department's resources will be spread over a field—that of education—which cannot be specifically described as scientific and industrial research. Scientific and industrial research has, of course, a certain educational value, both in its execution and in the dissemination of its results, and it would be impracticable to draw a sharp distinction between the research and the educational functions of the Department. None the less, a stage appears to have been reached when the Department's expenditure as presented may give a fictitiously high impression of the actual expenditure on research; some means should also be sought of giving a figure for its educational activities. This is important, less perhaps in relation to the Department's own accounts at present than in relation to the national expenditure on higher education. It is an argument for a more determined effort to obtain an overall picture of the distribution of the resources of Great Britain in research, in university education, in technological education and in technical education, in such a way that sound decisions are possible as to re-allocation where necessary, and at such a level that effective action can be taken without being thwarted by sectional views or departmental prejudice.

IMPORTANCE OF PORPHYRINS IN MEDICINE

Porphyryns

Their Biological and Chemical Importance. By Prof. A. Vannotti. (Translated by Prof. C. Rimington.) Pp. ix + 258 + 15 plates. (London: Hilger and Watts, Ltd., 1954.) 50s. net.

IN 1937 the firm of J. Springer, Berlin, published a book entitled "Porphyryne und Porphyryrkrankheiten" by Dr. A. Vannotti, professor of medicine in the University of Lausanne. That book, which ably summarized the clinical literature on porphyrias and related conditions and other biological work, has not been available in Britain for some time. In addition, a large amount of work has been done in this field

in recent years, and the publication of the present volume is welcomed. Clinicians and others with special interests in porphyrins will be grateful to Prof. C. Rimington for having undertaken the task of translating the book into English.

The main value of the book lies in the chapters dealing with the clinical and pathological aspects of porphyrins. Here Prof. Vannotti draws upon his own wide experience and his intimate knowledge of the clinical literature. Many original papers, to which reference is made, have appeared in European journals not readily available, and this feature makes the book particularly valuable to the English-speaking reader. Specialists will not always agree with Prof. Vannotti, for example, in his assessment of vitamins in the treatment of porphyria. There is also some doubt whether some of the methods, such as those recommended for the separation of porphyrins, are sufficiently reliable or accurate according to modern standards. Nevertheless, this book will be of value to the clinician or pathologist interested in porphyrias or other conditions in which increased amounts of porphyrins are excreted.

Prof. Vannotti states in his foreword that this book "is, in no sense, a mere revision of the older monograph, but a new book embodying modern conceptions of pigment metabolism". But the reader who expects on seeing the title and sub-title an up-to-date account of the organic chemistry, physical chemistry, biosynthesis or metabolism of porphyrins will be somewhat disappointed. The structural chemistry is given in a very elementary form, and the physical chemistry is curiously old-fashioned. Neither can the treatment of the general biochemistry of the porphyrins be considered satisfactory. Thus no reference is made to the important work of Granick, which shows that porphyrins are precursors of chlorophyll in algae. Recent results elucidating, by means of isotopes, the steps leading from glycine and succinic acid to porphyrins are mentioned, but are not adequately discussed, nor are they woven into the general fabric of the book.

One feels therefore that, while this book of Prof. Vannotti will be of great value to the medical, and particularly clinical, reader, it cannot be recommended as a general introduction into the chemistry, biochemistry or biology of porphyrins.

A. NEUBERGER

PSYCHOLOGY AND MYTHOLOGY

The Origins and History of Consciousness

By Dr. Erich Neumann. (Translated by R. F. C. Hull.) Pp. xxiv+494+27 plates. (London: Routledge and Kegan Paul, Ltd., 1954.) 30s. net.

THIS book is *not* concerned, as its title might lead the unwary reader to suppose, with the classical problem of the emergence of consciousness in the evolution of living matter: it is concerned with the emergence of consciousness from 'the unconscious mind'. The central theme is yet another psychological variant of the thesis that 'ontogeny recapitulates phylogeny'. What is distinctive of this variant is the idea that both the ontogenetic and the phylogenetic sequence correspond to that of a series of mythologies, these mythologies being symbolical projections of struggles within the human psyche.

"It is the task of this book", writes the author, "to shew that a series of archetypes is a main constituent of mythology, that they stand in an organic relation to one another, and that their stadial succession determines the growth of consciousness". This is fairly clear, but the author proceeds: "Normally the archetypal stages are lived through without disturbance, and the development of consciousness proceeds in them just as naturally as physical development proceeds in the stages of bodily maturation. As organs of the psyche's structure the archetypes articulate with one another autonomously, like the physical organs, and determine the maturation of the personality in a manner analogous to the biological hormone-components of the physical constitution".

Gathering momentum, the argument plunges to quite incredible depths of obscurity. The following is fairly representative of the style and texture of the exposition: "Besides possessing an 'eternal' significance, the archetype also has an equally legitimate historical aspect. Ego consciousness evolves by passing through a series of 'eternal images', and the ego, transformed in the passage, is constantly experiencing a new relation to the archetypes. Its relation to the eternality of the archetypal images is a process of succession in time—that is to say, it takes place in stages. The ability to perceive, to understand, and to interpret these images changes as ego consciousness changes in the course of man's phylogenetic and ontogenetic history; consequently the relativity of the eternal image to the evolving ego consciousness becomes more and more pronounced".

The work, however, is clearly addressed to advanced students of Jungian psychology, and for them no doubt it is an essential text. It is commended to them in a foreword by Jung himself. He describes it as beginning where he himself, were he granted a second lease of life, would start to gather up the *dissecta membra* of his own writings. He commends it, too, as presenting "a unique history of the evolution of consciousness", and as representing the body of myths as the phenomenology of this same evolution.

It would certainly seem that the author has something important to say, but it is difficult not to believe that what he has to say could have been said more clearly.

C. A. MACE

CHEMICAL SPECIFICITY IN BIOLOGICAL INTERACTIONS

Chemical Specificity in Biological Interactions

Edited by Frank R. N. Gurd. (Memoirs of the University Laboratory of Physical Chemistry Related to Medicine and Public Health, Harvard University—No. 3.) Pp. xv+234. (New York: Academic Books, Inc.; London: Academic Books, Ltd., 1954.) 6 dollars.

A PART from the introductory chapter by the late Dr. E. J. Cohn, this book consists of two independent parts, the first of which is made up of five papers, as follows: the effects of X-ray and other radiations on proteins and living tissues, by S. Warren; physical and chemical properties of the steroids related to protein binding, by R. B. Turner; biochemical problems of the steroid hormones, by T. F. Gallagher; some studies on the active principles of the posterior pituitary gland, by V. du Vigneaud; and the influence of ion-exchange chromatography

upon our concept of the structure of ribonucleic acid, by W. E. Cohn. This is a rather heterogeneous collection of titles; though they could each deal with the subject of the symposium from a different point of view, the authors do not really appear to have this in mind. However, each of these five papers is a very clear exposition written by distinguished people about their own researches. The lectures published here, were originally delivered at Harvard in February and March 1952. Clearly, seminars on original researches lose much if published two and a half years later.

The second part of the book consists of four papers by C. D. Coryell, J. Schubert, G. Schwartenbach and G. Scatchard (with W. L. Hughes, F. R. N. Gurd and P. E. Wilcox) which present a unified story.

Before the Second World War the main interest of the Department of Physical Chemistry at Harvard University Medical School was in the ionizing groups of amino-acids, peptides and proteins and the properties of these compounds which are a consequence of their ionic side-chains. After the War such knowledge was applied in a number of laboratories to the study of the interaction of amino-acids and proteins with metals and other ions. The results of such studies can give information about the reactive groups on the surface of protein molecules, they can define the catalytic sites of enzymes and they can give information about the specific role of certain metals in some enzyme catalysis mechanisms. Furthermore, E. J. Cohn and his colleagues have made great use of specific metal-protein interactions for the purification of certain proteins.

The four papers of the second half of the book deal with the fundamental aspects of the interaction of metals with small molecules and proteins from a theoretical point of view, and give a good review of the available experimental results. Such a good account of the work in this field, which is going on at Harvard and in several other laboratories, is very welcome. It is a pity that some of the space of this volume has not been devoted to quantitative data for van der Waals forces in specific protein-protein, enzyme-substrate and antigen-antibody interactions.

H. GUTFRUND

ION-SOLVENT INTERACTION IN SOLUTIONS

ionic Processes in Solution

By Dr. Ronald W. Gurney. (International Chemical Series.) Pp. ix+275. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 46s. 6d.

THE properties of an electrolyte solution are influenced by long-range Coulomb forces, by the effect of each ion on the solvent molecules in its neighbourhood, and by the nature of the close-range forces when ions approach one another and their zones of modified solvent interact. Since the acceptance of the Debye-Hückel theory, the centre of interest in electrolyte solutions has been in the shorter-range forces between ion and solvent or between ion and ion; but though data have continued to be accumulated, their interpretation has been dependent on advances in our understanding of the nature of liquids.

In this book by the late Dr. R. W. Gurney attention is focused on the solvent molecule, and his novel treat-

ment leads him to some very interesting and suggestive conclusions. Picture a group of water molecules arranged in the open liquid structure. The central molecule will have four nearest neighbours tetrahedrally arranged, two with protons directed towards negative regions of the central molecule and two with the opposite orientation. Outer molecules of the group will contribute to the stability of this arrangement. If now the central molecule is replaced by an atom of nearly equal size on which we imagine an electrical charge of gradually increasing magnitude to accumulate, the state of lowest potential energy will eventually be one in which the four water molecules in contact with the ion each has a proton, pointing towards it, if the charge is negative, and vice versa if it is positive. But before the ionic charge has become large enough to impose this arrangement, it must have passed through a critical value for which there is no preferred direction of the adjacent molecules. Gurney considers that this critical value is only a little less than the electronic charge itself, so that rather large univalent ions, like the caesium and bromide ions, will produce disorder in the solvent surrounding them, whereas small or multiply-charged ions will be able to set up around themselves a new arrangement of local order more stable than that existing in pure water.

As a primary criterion of the order-disorder situation, Gurney uses the viscosity coefficients of the ions. Wolfenden and his collaborators pointed out many years ago a correlation between these viscosity coefficients and the temperature coefficients of the ionic mobilities; for example, at ordinary temperatures the caesium ion, which has a relatively high mobility and low temperature coefficient, reduces the viscosity of water, and all these effects can be attributed to a loosening of the water structure. Gurney takes this further, and shows a striking relation between the viscosity coefficients and the entropies of solution, and, finally, a correlation between the activity coefficients of uni-univalent electrolytes and the order-producing or order-destroying characteristics of their constituent ions.

Dr. Gurney does not give a discussion of ion-pair formation, but here, too, his methods are suggestive. The experimental dissociation constants derived by semi-empirical methods for such electrolytes as caesium chloride have for long been regarded as 'impossible' by many physical chemists because (a) quantum-mechanical forces will be absent, and (b) Bjerrum's electrostatic treatment predicts no association between such large ions in water. The reply to this argument has been that an electrostatic theory using the normal dielectric constant of water cannot give quantitative results for ions at their minimum distance of separation; and this is given substance by Gurney's picture of conditions in the co-sphere of solvent surrounding each ion. As these overlap, the resulting free energy change is equivalent to a substantial short-range force of attraction (or repulsion) between the ions, in terms of which the ion-pair may be more sharply defined.

These comments by no means exhaust the topics to which this book supplies a fresh approach. Everyone interested in the dissociation constants of weak acids should read the treatment of acid-base equilibria, in which again the importance of the entropies in water of the anions is emphasized; and readers, whether they agree with everything said or not, will find the whole book stimulating and provocative.

C. W. DAVIES

Introduction to Elliptic Functions, with Applications
By F. Bowman. Pp. 115. (London: English Universities Press, Ltd., 1953.) 12s. 6d. net.

THIS book is for the use of physicists or engineers who desire a knowledge of those properties of elliptic functions which are useful in applications. It deals only with the Jacobian functions; the Weierstrassian functions are excluded. The first chapter shows how ordinary trigonometrical functions can be derived from the inversion of a definite integral, and how a similar procedure leads to the Jacobian elliptic functions, the properties of which for a real variable are then deduced. The second chapter deals with elliptic integrals of the first, second and third kind. The third chapter gives applications to geometry, dynamics, spherical trigonometry and potential. The fourth chapter again uses the analogy with trigonometry to deal with the case of complex variables.

Then follow no less than four chapters on the theory and applications of conformal transformation of elliptic functions and integrals. The applications include hydrodynamics, using the Schwarz-Christoffel transformation, electricity and magnetism. It is rather surprising to see Landen's transformation, a purely mathematical result, deduced from a physical problem. The ninth chapter shows how an integral, the integrand of which is the reciprocal of the square root of a quartic, can be reduced to the standard forms discussed in the second chapter. The tenth and last chapter is more difficult than the rest of the book; it deals with the rather heavy reduction of a certain degenerate hyperelliptic integral, and applies the result to a problem concerning an electric condenser.

The book concludes with a bibliography of textbooks and numerical tables, lists of formulae and an index. A valuable feature is the large number of examples. The book should be found very useful.

H. T. H. PIAGGIO

Jiří Procházka: Úvaho o Funkcích Nervové Soustavy

(Georgius Prochaska: De Functionibus Systematis Nervosi Commentatio). Edited by M. Petrán and E. Gutmann. (Prague: Academia Scientiarum Bohemoslovenica, 1954.)

GEORGE PROCHASKA (1749-1820), successively professor of physiology at Prague and Vienna, is now recognized as one of the most important pioneers of our knowledge of reflex action. He introduced the concept of the *sensorium commune* within the central nervous system, impressions conveyed in the sensory nerves being 'reflected' there upon the motor nerves. He was also the discoverer of the olivary bodies and foreshadowed several later neurological generalizations. His great work on the functions of the nervous system, written in Latin, "De Functionibus Systematis Nervosi Commentatio" (Prague, 1784), has now been reproduced in facsimile by Dr. M. Petrán and Dr. E. Gutmann, together with a Czech translation and introduction, and abundant notes. Their book is in typography and lay-out of high standard, and quite worthy of the historical achievements which it commemorates and expounds. Indeed, it constitutes a model for such productions, for it is equipped with an exhaustive index and an admirable biographical glossary of the outstanding physiological writers and research workers of Prochaska's own time and the preceding period. The only regret that can be voiced is that the excellent introduction was not given in one of the Western 'congress' languages as well as in the Bohemian

tongue. But it is good to see such honour paid to one of the greatest forerunners of Setchenov, Pavlov and Sherrington.

JOSEPH NEEDHAM

An Introduction to Pathology

By Prof. G. Payling Wright. Second edition. Pp. xii+636. (London: Longmans, Green and Co., Ltd., 1954.) 40s. net.

THE period following the outbreak of the Second World War was marked by a gradual change in the approach to several of the basic medical sciences. Pathology ceased to be based largely on morphology, and it came increasingly to be regarded as a subject which should be approached from the functional point of view. Many years ago Sir Michael Foster said that the science of meteorology could not be divided into the science of good weather and the science of bad weather, but the full significance of his remark was long unheeded by pathologists. This excellent work by Prof. G. Payling Wright was perhaps the first book on general pathology to follow this method to its logical conclusion. First published in 1950, it was reprinted twice. The new second edition includes additional chapters on the general manifestations of allergy and on the effects of ionizing radiations.

This work is an ideal introduction to clinical work, since it is based throughout on the etiological and functional approach. A third of the book is devoted to tumours, and the large sections on the causation of new growths is a masterly discussion of an enormous field. The usefulness of the book is enhanced by the historical treatment of the subjects, and the references which were given in the first edition have been increased. This popular work is a real inducement to the student to carry his reading further.

Science and its Background

By Dr. H. D. Anthony. Second edition. Pp. ix+337. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, 1954.) 20s. net.

A SECOND edition of Dr. Anthony's useful book is welcomed, and it is pleasing to know that the work has had such a wide vogue already. To his short and readable account of the history of human affairs as they have been modified by man's increasing knowledge and use of natural phenomena, the author has added two additional chapters. In the first he discusses the post-war utilization of scientific developments, and in the second, the pursuit of science for its own sake.

Clerk Maxwell's optimistic inaugural address as Cavendish professor, in 1871, is more than ever in need of fulfilment—"the popularization of scientific doctrines is producing as great an alteration in the mental state of society as the material applications of science are effecting in its outward mental life" For this Dr. Anthony's book, which is free from the political bias which has marred more pretentious works, is a good introduction.

It is a pity that the second edition had to go to press before the Piltdown hoax had been fully exposed, and another dawn had broken upon *Boanthropus*! But if the very elect were deceived for so long a time, the interpreter of their works and ideas can scarcely be blamed.

There is a photograph of the Leaning Tower of Pisa to illustrate the account of Galileo's weight dropping experiment. It would be interesting to try to find the origin of the Leaning Tower legend

W. L. SUMNER

THE METEOROLOGICAL OFFICE, 1855-1955

By SIR GRAHAM SUTTON, C.B.E., F.R.S.

Director

THE State meteorological service of Great Britain came into being in 1855 as the Meteorological Department of the Board of Trade, with Admiral Robert FitzRoy in charge. The word 'Office' was not used until 1863. The primary duty of the new Department was to collect observations on weather and ocean currents for the benefit of shipping. The possibility of scientific weather forecasts, as distinct from the traditional lore of the seaman and the farmer, had been realized for some time before FitzRoy took up his duties; and simple weather maps had been shown in the Great Exhibition of 1851 as an illustration of the potentialities of the telegraph. In 1860 FitzRoy, with Le Verrier of Paris, began the regular collection of observations by telegram, and in the following year a storm-warning system for ports was instituted and daily forecasts were supplied to the Press.

Soon after FitzRoy's death in 1865 the storm warnings and daily forecasts were suspended, on the advice of a committee of the Royal Society, on the grounds that the scientific knowledge available was inadequate for the preparation of forecasts. At the request of the Government, the committee assumed control of the Office in 1867, with R. H. Scott as its chief executive officer, a post which he held, under one title or another, until the end of the century. Largely because of the enthusiasm of Sir Francis Galton, the committee equipped seven observatories with instruments for the continuous recording of pressure, temperature, wind and rainfall and began the systematic study of the form and movements of atmospheric disturbances. By 1879 sufficient confidence had been acquired for the resumption of the publication of forecasts; but probably the most significant event of this period was the first of a long series of international conferences for the standardization of methods of making and reporting observations, held in Leipzig in 1872.

From 1877 onwards the official service was controlled by a paid Meteorological Council, the secretary of which acted as director of the Meteorological Office. The service was almost entirely operational and research was left to outside workers.

Influence of Napier Shaw

Scott retired in 1900 and the Meteorological Council invited Dr. (later Sir) Napier Shaw, a well-known Cambridge physicist, to take his place. This was a highly significant choice, and perhaps the most important event in the history of the Office. Shaw not only gave direction and impetus to the scientific aspects of the service, but also began to attract into the Meteorological Office men of real scientific ability, such as Ernest Gold and R. G. K. Lempfert. He also enlisted the aid of W. H. Dines, perhaps the most gifted designer of meteorological instruments that the world has known. Dines was never a member of the staff, but throughout his life remained closely connected with the official service.

The most active period of Shaw's directorship, from 1900 to the outbreak of the First World War, undoubtedly placed the Meteorological Office in the forefront of the meteorological services of the world.

Dines's instruments, in particular the pressure-tube anemometer, the balloon meteorograph and the radiometers, provided a wealth of reliable data, and forecasters began to argue more by physical principles and to rely less on analogies with past situations. The philosophy of the science during this period is perhaps best summed up in Shaw's classical book, "Forecasting Weather", first published in 1911. This work (which is much in the tradition of Clark Maxwell's "Heat") is now largely outmoded, but still remains as a delight, not only for the elegance and clarity of the writing but also because of the shrewd blend of fluid dynamics and thermodynamics with the practical business of synoptic analysis for the routine forecast.

Progress, however, was limited because of the lack of the third dimension, and the typical atmospheric disturbance had perforce to be regarded as something taking place in the horizontal plane. Upper winds could be observed only in clear weather, and although the balloon meteorograph had established much of the climatology of the high atmosphere, the success of a sounding depended entirely on the chance of recovering the record intact after the balloon had burst. The forecaster was denied up-to-date knowledge of temperature and humidity except at the surface, for the aeroplane was still in its infancy. Nevertheless, considerable strides were made. Gold's classical study of upper winds brought out forcibly the dominating influence of the geostrophic balance, and the Shaw-Lempfert analysis of the trajectories of air masses laid the foundation for the subsequent Norwegian work on frontal theory.

Administrative Structure

During the First World War, the urgent need for specialized meteorological information led to the formation of separate services for the Navy, Army and Royal Air Force; but in 1920 the Government took the decisive step of uniting the various services under the Air Ministry. This arrangement, which was viewed with misgiving by some meteorologists, continues to the present day, except that the Admiralty retains control of its own Naval Weather Service. The general policy of the Meteorological Office is the responsibility of the Secretary of State for Air, who is advised by the Meteorological Committee, composed of representatives of the Royal Society, British universities and various Government departments. Financial control is exercised by the Air Ministry through the usual Civil Service machinery, but the Director of the Meteorological Office acts directly under the authority of the Permanent Under-Secretary and not through the Air Council. In practice, this means that the Office, although necessarily in close contact with the Royal Air Force, remains a very individual element of the Air Ministry and carries out its primary duty of acting as the State Meteorological Service, with the advantages that accrue from attachment to a large Department of State. At present, the staff number more than 3,000 and Air Ministry estimates for 1955-56 provide nearly £3½ million for meteorology.

Development of Aeronautical Meteorology

In 1920 Sir George Simpson succeeded Sir Napier Shaw as director, a post he held until his retirement in 1938. This period in the history of the Office coincided with the rapid development of aviation. The First World War had seen a great increase in the number of professional meteorologists, the most notable accession being Captain (now Sir David) Brunt, who became superintendent of Army Services, a post which fortunately allowed him opportunity to engage in the researches which have since made his name famous. Against this must be set the loss of L. F. Richardson, who resigned from the post of superintendent of Eskdalemuir Observatory (the geophysical observatories of Kew and Eskdalemuir had passed from the control of the National Physical Laboratory to the Meteorological Office in 1910) on conscientious grounds, but not before he had sown the seeds of 'numerical forecasting' by his work on the integration of the equations of atmospheric motion. Nearly thirty years had to elapse before the invention of the electronic digital computer made this concept practicable for operational forecasting.

Under Simpson, the Office developed into an efficient technological organization, especially well adapted to serve the ever-growing needs of aviation, both military and civil. Despite the fact that research was not organized on any large scale within the Office, but was left to the efforts of individual workers, the period between the Wars was one of great scientific activity. Forecasting received its greatest forward impulse in the development of the Bjerknes polar-front methods of analysis, and Simpson and Searse did much valuable work on the structure of thunderstorms. At Porton, N. K. Johnson (who later succeeded Simpson as director), working largely under the guidance of Brunt, laid the foundations of micrometeorology. The greatest advances, however, were in the field of instrumentation, the most significant feature being the application of telemetering techniques to the measurement of winds, pressure, temperature and humidity by free balloons equipped with small radio transmitters. For the first time, the properties of the atmosphere could be recorded as the balloon ascended, regardless of the presence of cloud. This in turn meant that the structure of the atmosphere in depth became known to the forecaster in time for him to include these factors in his analysis.

The Second World War and Afterwards

Sir George Simpson retired in 1938 and was succeeded by Sir Nelson Johnson. The necessity of a research organization within the Office was recognized by the appointment of an assistant director to supervise investigational work, but any further plans were disrupted by the outbreak of war. During the next six years the demands for operational forecasts became enormous, and the staff was increased tenfold to a maximum of about six thousand by the recruitment and training of scientists from other professions. The technique of forecasting changed as upper-air data became more abundant, and the idea of studying the absolute and relative topographies of surfaces of constant pressure gradually became established. In 1942 the Meteorological Research Committee was formed and has continued in being ever since. It has three sub-committees which maintain an active interest in all the research activities of

the Office. The sub-committees deal on the average with some forty or so 'Meteorological Research Papers' every year, most of which are original contributions by members of the staff. The same year saw the formation of the Meteorological Research Flight, which operates from the Royal Aircraft Establishment, Farnborough, and has provided much reliable information on the structure of the high atmosphere, especially in relation to its water vapour content.

Sir Nelson Johnson retired in 1953 and I was appointed to succeed him.

At the present time the Office operates under the director, the principal deputy director (Dr. J. M. Stagg), and three deputy directors in charge of forecasting (Mr. S. P. Peters), services (Dr. A. C. Best) and research (Dr. R. C. Sutcliffe), respectively. The research activities of the Meteorological Office now cover a very wide field and it is possible to mention here only a few of the more prominent items. The advent of the high-speed computer has directed attention to the possibility of forecasting the development of the pressure field over a limited area by the step-by-step integration of the hydrodynamical equations. This concept was first introduced by L. F. Richardson in 1922; but the modern approach arises more from the work of C. G. Rossby on long waves and the pioneer studies of R. C. Sutcliffe on the relation between vorticity and cyclonic development. These ideas have been applied to simple atmospheric models by a number of workers, chiefly Charney and Thomson in America, and Sawyer and Bushby in Britain. In this way predictions of the pressure field for the next 24-48 hr. can be made in a time sufficiently brief for the forecast to be used operationally. So far, the method has not been taken beyond the research stage, but enough has been done to show that there are considerable potentialities in this approach. On the other hand, little or no success has been achieved with forecasts for longer periods, and the problem of predicting the general nature of, say, the next winter remains as baffling as ever. In the field of instrumentation, the Dobson-Brewer frost-point hygrometer has been developed successfully for use by the Meteorological Research Flight, and the final stages in the production of a new radar-sonde equipment, capable of exploring the atmosphere to heights of the order of 100,000 ft., are in sight. This equipment, the most advanced in the world, has been developed jointly by the Instrument Division of the Meteorological Office, the Radar Research Establishment (Malvern) and Messrs. Mullard, Ltd.

On the operational side, the key station is the Central Forecasting Office, Dunstable, which collects information from all parts of the world and redistributes it to local forecasters at military and civil aerodromes throughout Britain. Climatological work is concentrated at Harrow, where an expert advisory service is maintained to meet the needs of industry, transport and the public generally. Broadcasting has become the principal means whereby the forecasts reach the public, and the Office supplies a team of forecasters to the B.B.C. Television Service for this purpose. An automatic telephone service for the London area is soon to come into operation—at the present time the forecast office at Kingsway, London, has to deal with about 80,000 telephone inquiries annually.

No account of the Meteorological Office, however brief, should omit a reference to international

activities. During the hundred years of its existence, the Office has played a large part in fostering international co-operation in meteorology, and the late Sir Nelson Johnson was president of the International Meteorological Organization during the critical post-war period when the Organization handed over its responsibilities to the World Meteorological Organization, one of the Specialized Agencies of the United Nations. The staff of the Office take a large part in the activities of the World Meteorological Organization, especially in relation to its technical commissions, and the meteorologist has to accept foreign travel as an integral part of his official duties.

The greatest handicap from which the Meteorological Office has suffered during its first hundred years has been the neglect of meteorology as a subject for systematic study by British universities generally; but there are now welcome signs of an awakening of interest. The Office has placed research contracts with the universities of Oxford, Cambridge, London and Wales (University College, Aberystwyth), and has stimulated interest in the science by inviting members of university staffs to serve on the Meteorological Research Committee. The need for basic study is, however, pressing, and although the Office has now a large and well-developed research side, backed by one of the finest collections of meteorological literature in the world, the professional meteorologist requires more than ever the support of the academic worker to help him to grapple effectively with the many problems that await solution.

THE GOVERNMENT LABORATORY POLONIUM SERVICE

IN April 1930, Dr. (now Sir George) G. C. Simpson, then director of the Meteorological Office (Air Ministry), approached Sir Robert Robertson, who was Government Chemist at the time, with the request that the Government Chemist's Department should undertake the polonium plating of the 'collectors' of the instruments used for measuring atmospheric potential gradient at the observatories at Kew, Eskdalemuir, Dumfriesshire and Lerwick, Shetland.

The 'collectors' are copper rods, 3 in. long tapped to a 2.B.A. thread at one end, and they are plated with polonium for about half an inch at the other end. The originals were supplied by the Meteorological Office, but replacements have since been made in the Government Laboratory workshop. Experimental work has also been carried out with a split collector, plated over a narrow band in the middle of a cylinder 2 in. long, and $\frac{3}{8}$ in. in diameter, that is made in two pieces for clipping on to a wire. In use, the standard type of collector is screwed to a rod projecting from the wall of a building, the rod being connected to the needle of a quadrant-type electrometer.

The record is standardized by measurements over open level ground. Before the introduction of the polonium-coated type, Kelvin 'water drop' electrodes were used at Kew and Eskdalemuir, and a spiral wire coated with a preparation containing radium at Lerwick. Potential gradient measurements have been made at Kew since about 1840, and the record is tabulated since 1898. The quadrant electrometer in

use at present was set up in 1886; it is a slight modification of a very early model installed personally by Lord Kelvin in 1873.

Prof. Sidney Russ, of the Middlesex Hospital, supplied the Government Chemist's Department with used radon tubes, and from them Mr. C. O. Harvey prepared the plating solutions as radium D, E and F in $N/2$ (5 per cent) hydrochloric acid; though since 1935 the solutions have been made up in 0.15 N (1 per cent) nitric acid, which was found to be more satisfactory. On May 9, 1930, the first collector was dispatched to Kew Observatory, and since then more than four hundred collectors have been sent to the observatories at Kew, Lerwick and Eskdalemuir. The work, originally in the care of Mr. Harvey, has since been performed by Mr. J. L. Buchan, Dr. P. J. Hardwick, Dr. C. R. Hoskins and Mr. A. D. Baynes-Cope in succession.

The techniques used are kept as simple as possible. Plating is by autodeposition, during 24 hr., from a magnetically stirred solution. Each of the six solutions used contains about $\frac{1}{2}$ mc. of radium D and is used about once every three months, allowing ample time for polonium to be regenerated from the radium D. Copper accumulates in the solutions, and is removed every two years.

The service was not interrupted in any way by the Second World War, and the only recorded mishap came in January 1953, when the collector in use at Lerwick was blown away in a blizzard. A fresh collector was dispatched within twenty-four hours, and later, the collector was recovered, bent but still active and serviceable.

During 1954, information on the length of useful service was obtained from the observatories, and experimental data were obtained in the Government Chemist's Department. It was found that the loss of efficiency in collectors was due more to adverse weather conditions than to normal radioactive decay processes. The fog of December 1952 almost completely deactivated the collector at Kew, whereas in fine weather in the spring in 1954 the Lerwick collector lost only a little more than the theoretical amount of activity.

This account is published by permission of the Government Chemist, Dr. G. M. Bennett.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1953-54

IF the persistence with which questions have been asked in the House of Commons in recent months concerning the Department of Scientific and Industrial Research is any guide, the Department's report for the year 1953-54* should be received with exceptional interest. It includes a short report of the Committee of the Privy Council, over Lord Salisbury's signature, and the thirty-ninth annual report of the Advisory Council, signed by Sir Hugh Beaver; there is also the usual summary of work carried out by the various research stations and boards and research associations—in fact, the report follows the usual pattern of recent years. Besides a summary of the Department's expenditure for the

* Department of Scientific and Industrial Research. Report for the year 1953-54. (Cmd. 9386.) Pp. 326. (London: H.M. Stationery Office, 1955.) 9s. net.

year ended March 31, 1954, there are appended lists of assessors to the Advisory Council, of the various committees of the Advisory Council, research boards of the Department and their membership, of grants for special researches in progress or authorized during the year and a 27-page list of publications issued during the year.

There is thus much useful material in its three hundred odd pages to assist either a member of Parliament or of the general public to form a sound opinion as to the value the nation is getting for an expenditure of £5,865,279 in 1953-54 and for which £6.5 million is provided in the Civil Estimates for 1955-56. Nevertheless, as questions being asked in Parliament indicate, the report does not really provide the background information by which the soundness of the distribution of Britain's effort in this field as a whole can be judged. The Department's expenditure of £6 million has to be set against a figure of £200 million or more on civil research in the Civil Estimates; nor does this figure take account of expenditure by industry on like purposes, of defence research, which may have relation to civil needs, or of that being carried out by the public corporations. The absence of any such broad background information means that judgment on particular items of expenditure by the Department must be made with reserve. Nor is there evidence that any steps are being taken to improve the clumsy and indirect arrangement by which questions regarding the Department's activities are handled in the House of Commons, to provide the Lord President of the Council with an adequate staff, or to strengthen the Department's Intelligence and Information Division sufficiently to enable it to deal adequately with the matter of public relations, neglect of which appears to be responsible for a considerable proportion of Parliamentary questions.

The gross expenditure of £5,865,279 compares with £5,773,303 gross in the previous year and is reduced to £5,254,342 by various receipts (£317,970 being by the National Physical Laboratory) for work done for other government departments or for industry, the net increase on 1952-53 being £46,887; the estimates for 1954-55, as approved, provide for a further increase of £578,379. On October 1, 1954, the Department employed 4,220 staff of all grades (including 164 part-time), compared with 4,073 (159 part-time) the previous year. Annual grants to research associations totalled £1,254,088 (compared with £1,449,635 in 1952-53), with a special grant of £1,839 and grants for special researches amounting to £412,431 (£317,321 in 1952-53). Grants to students amounted to £295,419, an increase of £29,522, the number of students in training being 1,009 compared with 976, and of these 415 were new. Of the eleven senior research awards, four were new, and 26 new grants for special researches brought the total of such grants to 58, compared with 70 in 1952-53 and 91 in 1951-52. Six of these awards were in physics, three in chemistry and one each in biology and engineering; and of the grants for special investigations, twenty-five were in physics, seventeen in chemistry and four each in mathematics and astronomy, in biology and in engineering. Chemistry claimed 427 and physics 300 of the students receiving grants; 99 were in engineering, 97 in biology, 38 in mathematics and astronomy, 32 in geology and 16 in metallurgy.

Expenditure of £831,019 gross or £513,049 net on the National Physical Laboratory was slightly less

than in 1952-53 (£546,617 net). Expenditure of £314,407 on mechanical engineering was £31,750 less than in 1952-53; but although net expenditure on building research (£411,594), fire research (£25,355) and forest products research (£101,252) was also less than in the previous year, the decrease was only slight. Expenditure on research contracts, however, decreased from £9,289 to £2,589.

Net expenditure on the Chemical Research Laboratory increased by £10,779 to £124,353, on food investigation by £71,587 to £292,118, on fuel research by £9,292 to £246,984, on the Geological Survey and Museum by £6,601 to £210,732, on hydraulics by £3,886 to £61,562, on pest infestation by £2,121 to £58,757, on radio research by £43,678 to £94,397, on road research by £12,567 to £305,532, and on water pollution by £1,249 to £62,673. Headquarters, administration, etc., accounted for £220,379, compared with £213,119, and £42,483 was provided for European nuclear research.

For the latter purpose, £360,000 was provided in the Estimates for 1954-55, and this has been further increased to £520,000 in the Estimates for 1955-56; so that a considerable proportion of the increase in the Department's estimates over the two years is represented by grants for work outside Great Britain. With Great Britain's expenditure on the Atomic Energy Authority already running at £50 million a year, this addition needs to be remembered in considering the allocation of scientific effort, while of the Department's grants of £400,000 for special researches, some £300,000 a year is for support of nuclear physics research in universities. For this latter purpose the Advisory Council has now constituted the Nuclear Physics Sub-Committee of its Scientific Grants Committee as a full committee, the terms of reference of which include, besides the consideration of applications for grants, the keeping under review of the scientific aspects of the Department's responsibilities arising from the United Kingdom's membership of the European Organization for Nuclear Research.

Government Establishments

The Advisory Council now reports substantial progress in the building of the new Mechanical Engineering Research Laboratory at East Kilbride, where the hydraulic machinery laboratory is approaching completion and new laboratories for the Divisions of Heat, Mechanisms and Metrology are likely to be started soon. The non-industrial staff is now 190, an increase of 25 per cent during the year, and recruitment of a further 40 has been authorized. In the Divisions of Mechanics and Materials, loads and stresses occurring in engineering components in service and the way materials behave when subject to these stresses are being determined by analytical or experimental methods, so that more efficient use can be made of existing and new engineering materials. The emphasis is on repeated loading, that is, fatigue, and on materials for use at high temperatures, including the continuous deformation of metals under steady loads. In the Fluid Mechanics Division modern knowledge of fluid dynamics, especially that gained in aerodynamics research, is being applied to mechanical engineering problems, for example, with the view of improving the efficiency of water-turbines, pumps and other hydraulic machinery. In a fourth Division, the study of the fundamental causes of friction and wear between rubbing surfaces and of techniques for their reduction in machinery has con-

tinued. Electron microscope examination indicated that unused lubricating oils for diesel engines containing 'heavy-duty' additives were true solutions. Tests in which the flow of lubricant through a high-speed bearing has been followed by using a transparent outer bearing shell and introducing a fluorescent dye excited by ultra-violet light into the oil indicate the need for special care in designing the passages by which oil is introduced into the bearing. Basic components of mechanisms, such as gears, ball-bearings and universal joints, are being studied in the Division of Mechanisms and Metrology, to improve their operation and reduce noise, while the Plasticity Division is seeking a fuller understanding of the fundamental mechanism of plastic flow which should facilitate more efficient use of materials, more exact and economical design of machinery and a saving in power. The Division of Heat Transfer and Thermodynamic Tables is endeavouring to increase the efficiency of heat transfer equipment, including boilers, condensers, heat exchangers and many types of chemical engineering plant, and is preparing tables of thermodynamic properties of working fluids used in engineering, correlating and co-ordinating data from various sources. The Mechanical Engineering Research Laboratory was one of the Department's establishments visited by the Advisory Council during the past year.

At the Building Research Station, which was also visited by the Advisory Council, full-scale trials were carried out in conjunction with the National Federation of Building Trades Employers of the use of air-entrained sand-cement mixes for external renderings and internal undercoats to plaster, and of the use of zinc oxychloride paint as an additional means of preventing the spread of dry-rot in timber. Research on prestressed concrete continued with particular reference to the investigation of fire resistance in collaboration with the Joint Fire Research Organization, and it is now clear that sufficient protection can be given to prestressed concrete to allow its use in large structures where fire resistance is important. Results of an investigation, carried out in collaboration with the Metropolitan Water Board, indicate the possibility of dispensing with expensive steel lining in a proposed new deep-water tunnel some twenty-six miles long, with large savings in money. A major stage was completed in the investigation of single-stack plumbing, and design rules were published applicable to flats of up to five stories, which offer savings of 40-50 per cent in the cost of the pipe-work over conventional plumbing arrangements. The extensive site trials carried out with the use of rail-mounted tower cranes for two- and three-story buildings show that a considerable reduction of building costs can be expected on most sites. Good progress has been made in the study of alternative methods of house-construction using factory-made components and dry-finished interiors.

The Fuel Research Station was also visited by the Advisory Council during the year and the problems of this Station are receiving particular attention. The Advisory Council believes that the Station is still of high importance as a national centre for the study of fuel problems, and an immediate increase in staff has been recommended to accelerate work on atmospheric pollution and domestic heating. Experimental work on the gasification of coal fines with steam by the fluidized-solids technique continued, and increasing attention is being given to the flow

properties of residual fuel oils, where more fundamental knowledge is required if a satisfactory test, applicable to all types of residual fuel oils, is to be evolved. The radioactive tracer technique has been used to investigate the mechanism of formation of the alkali sulphates responsible for bonded deposits in boilers, and further development work has been carried out on different types of combustion chamber for burning solid fuel in industrial gas turbines. The facilities of the Calorimeter Building are fully occupied in the study of the heat distribution from various types of domestic heating appliance, and a new and improved instrument for recording and measuring domestic smoke has been developed.

Special reference is made in the Advisory Council's report to the work of the Road Research Laboratory and of the Food Investigation Organization. In the field of safety, the former has been concerned with the properties of toughened glass for windscreens, the construction of protective helmets of motor-cyclists and the value of yellow head-light beams, while the Laboratory's work on dazzle indicates that a great improvement in visibility could be obtained by improved setting of vehicle head-lamps. Several machines for spreading cement and mixing it into soil as a road basis, developed with the Laboratory's help, are now in production, and attempts are being made to isolate and identify the organic constituent in certain sandy soils which prevents the setting of cement; the results have now been published of a study of the rheological properties of a wide range of fine mineral powders when mixed with bituminous liquids, as part of an extensive investigation of the mechanical properties of dense bituminous mixtures used for surfacing roads.

The Food Investigation Organization comprises a headquarters in Cambridge and four divisions dealing, respectively, with biochemistry and biophysics; meat and meat products; fish and fish products; and fruit and vegetables. The Advisory Council is satisfied that the arrangements for liaison with the many other organizations concerned with such problems are satisfactory, but it has established, as an experiment, a standing consultative committee on food research, representative of all the various sections concerned, including the research associations. The work on frozen beef has shown that it is impracticable to freeze sides of beef before *rigor mortis* sets in; there is little danger that the use of blast tunnel freezers would damage beef by freezing it before the occurrence of *rigor mortis*, but it has yet to be shown that such early freezing is desirable. A specially designed diesel-electric trawler is being built to meet the research needs of the Torry Research Station, and it is also planned to install plant to freeze the first part of the catch on an existing Arctic trawler and to operate the vessel for twelve months. Studies have been made of the effects of the procedure used for freezing at sea on the quality of the fish. A major problem in the storage of home-grown apples is to reduce the amount of lenticel rotting, caused by *Gloeosporium* species, of Cox's orange pippins stored beyond Christmas. The types of canker and die-back produced on apple trees by this species have been identified, and inoculation experiments indicate that twigs of Cox's orange pippin trees are affected more rapidly than twigs of Bramley's seedling. Losses during storage are also caused by physiological changes within the fruit itself, one of the most troublesome being scald. It is now clear that exceptionally fine summers are more likely to

produce fruit susceptible to scald than are normal English summers, and that the earlier the fruit is picked, the greater the risk of scald: with early-picked apples the only satisfactory way of preventing scald is to wrap the fruit in oiled paper. Measurements are also being made of the loss of water from apples in commercial stores. Investigations of the phenolic constituents of plants have shown that the leuco-anthocyanins make an important contribution to astringency in cacao products, wines, fruits and fruit juices. Studies are being made on a semi-technical scale of the economic possibilities of ion-exchange processes for the preparation of ascorbic acid and other useful constituents from forage plants, and the route of synthesis of ascorbic acid from simple sugars has been discovered and effected enzymically *in vitro*.

The account of the work of these research establishments of the Department occupies some 80 pages of the report, and a further 115 are devoted to the work of the research associations. Only a few additional examples can be given to illustrate the range and magnitude of the Department's contribution to the national welfare. The work of the National Physical Laboratory and of the Chemical Research Laboratory has recently been reviewed in these columns. No more need be added here than that the Advisory Council directs attention to the formation at the former of a new Division for Electronics and Control Mechanisms, with a small group for studying the possibilities of increasing the mechanization of large-scale office work. This, it is believed, may make a major contribution to economy in the use of manpower. The Council also commends the two symposia, dealing with "Automatic Digital Computation" and "Engineering Dimensional Metrology", held at the Laboratory in 1953, as a valuable means of disseminating knowledge of the Laboratory's work and fostering the interchange of ideas with scientists and technologists outside the Department.

The Joint Fire Research Organization is to study reports of large fires in general, since these account for a high proportion of fire losses, and in the textile, dyeing, bleaching and finishing trades these major losses are associated with fires occurring outside working hours. Data for the design of explosion relief vents are being steadily accumulated, and basic studies have been made of the propagation of flame in dusts with the view of developing an improved test for measuring the explosion hazard of dust-laden atmospheres.

The demand for industrial information and advice from the Forest Products Research Laboratory remains high, and routine testing of new Colonial timbers is still a major project. Investigations have continued on the boring of quarter-sawn and flat-sawn material from various species, the torque and thrust being measured at different spindle- and feed-speeds. Service trials on railway sleepers begun in 1935 are nearing completion, and in the work on timber-rotting fungi attention has been given chiefly to the physiology of the group of Ascomycete fungi which give rise to 'soft rot'. Studies on the biology of the common furniture beetle are continuing, particularly on the effect of decay on the attack of the beetle.

The field-staff of the Geological Survey was engaged principally upon primary and revision six-inch mapping, 295 sq. miles being surveyed in 1953, priority in choice of ground being governed largely by economic considerations. Accounts have also been prepared of English rocks collected during current

field surveys and from boreholes drilled for economic minerals, including coal and potash. Two types of investigation by boring have been undertaken: the first to ascertain by deep boreholes the nature and distribution of the rocks lying some distance below the surface, and the second to amplify and extend the findings of mapping. Gravity surveying was continued in the English Midlands, and also the survey of the water resources of the Triassic Sandstone area there, as well as researches directed towards the discovery of new sources of raw materials for atomic energy installations.

Satisfactory progress is reported with the construction of the first stage of the main hall of the new Hydraulics Research Station. Investigation in the large model of the Thames Estuary of the heavy siltation occurring in the tidal basin at Tilbury has shown that certain training works would greatly reduce the inflow of silt-laden water and thus reduce the dredging required. Recommendations for remedial works based on these experiments have been submitted to the Port of London Authority. Other research has been concerned with the effect of sea-walls on beaches, and a mobile-bed model of Southwold Harbour, Suffolk, has been constructed to examine various means of reducing wave action in the harbour and the effect of these works and of proposed repairs and alterations to the harbour arms on littoral drift and siltation. A rigid-bed model has also been constructed for the investigation of a flood relief scheme proposed for the River Severn in the neighbourhood of Shrewsbury.

Pest infestation research continued on the same main lines as in the previous year, but the work on the infestation of slaughter-houses by blowflies and the study of the interaction of wheat protein with methyl bromide were completed. Considerable progress was made in the basic physiological research underlying the study of the mechanism of insecticidal action. The work on the hermetic storage of damp grain has aroused considerable interest, while investigations on the control of bean weevils indicate that admixture with each 200 lb. of beans of 6 oz. of a diatomite powder containing 0.05 per cent of gamma-benzene hexachloride ensures freedom from infestation if the insecticide is applied sufficiently early after harvesting. Continued experiments have shown that even heavy infestations by Pharaoh's ant, *Monomorium pharaonis*, in hospitals can be controlled by systematic application of chlordane, and a study of the practical control of the cacao moth in a London warehouse has been started.

The work of the Radio Research Organization has continued to be mainly concerned with wave-propagation; but it also includes semi-conductor research, particularly directed to understanding the physical processes occurring in point-contact and junction components and how these are related to their electrical behaviour. Work carried out at universities under contract from the Department includes very-low-frequency ionospheric research at the Cavendish Laboratory, Cambridge, high-frequency ionospheric research at University College, Swansea, work on transmission characteristics of surface waves at University College, London, and on dispersive artificial dielectrics and on ferromagnetic and ferroelectric materials at the Imperial College of Science and Technology, London. The new Water Pollution Research Laboratory at Stevenage was completed during the year, and the Laboratory has investigated the removal of certain radioisotopes

from water by processes normally used at water-treatment plants. Work on the biological filtration of sewage has confirmed the importance of periodicity of dosing in determining the efficiency of a filter; it has now been found that percolating filters can break down cyanides when these are supplied as solutions of potassium, zinc or cadmium cyanides in concentrations up to 160 parts of hydrogen cyanide per million. In an investigation on the effect on the River Colne, near Watford, of the discharge of effluent from a modern sewage treatment works, an attempt is being made to correlate the distribution of fish in the effluent channel with the chemical characteristics of the effluent. The survey of the Thames estuary is now mainly concerned with the factors affecting the oxygen balance in the estuary.

(To be continued)

THE PAINT RESEARCH STATION, TEDDINGTON OPEN DAYS

THE Paint Research Station at Teddington was opened to visitors during May 2-7. Most research institutes have such occasions, which call for good planning and showmanship if past achievements and future trends are to be adequately demonstrated. These qualities are not always integrated in research workers, but the director of the Station, Dr. L. A. Jordan, and indeed all the staff concerned, are to be congratulated on a most admirable presentation of their work, which undoubtedly had an impact of consequence on those attending, some 750 in all.

The subjects studied at the Station fall naturally into four broad divisions: media, pigments, paint manufacture, and paint utilization. As the visitors passed into the various rooms they were met by experts prepared to explain and expound the subjects under study or the apparatus on show. In addition to receiving the general laboratory guide, visitors were able to read and collect brief statements detailing the work dealt with in each room. There were fifty or more of these papers and some necessarily ran to four quarto pages. The scientific detail thus made available was considerable, and its practical objective was brought into focus by a short preface to each paper.

The appreciation by visitors of the inter-relations between the demonstrations in various laboratories and their setting was greatly assisted by short talks lasting not more than 20-30 min. given at intervals throughout the days. This arrangement fully achieved its object and, moreover, was a factor in preventing physical fatigue. The subjects were: (a) atomic energy, drying oils and the future; (b) alkyd resins research; (c) synthetic resin emulsion paints, their structure and properties; (d) accelerated weathering studies. A film prepared under the direction of the staff was also shown more or less continuously entitled "Benard Cell Effects in Paints". A good alternative title would have been, "the study of pigment flotation in paints and its control by the use of silicone oils". This was particularly interesting and intriguing, dealing with special features of a type of phenomenon with wide manifestations in Nature.

To-day paints are manufactured from a variety of new media, as well as from traditional materials, and

provide an ever-increasing scope for study. Tracer techniques are widely employed, and the Research Station now has its own source of γ -radiation whereby the study of various polymerizations and other reactions in drying oils and related materials is proceeding apace.

The alkyd resin concept as it has come to fruition in the production of paint media of admirable quality is still a comparatively recent matter; by contrast, the heat-treatment processing of drying oils, such as linseed oil, tung oil and some others, is almost as old as paint itself. In these fields of work the Research Station continues to make an outstanding contribution, now assuming added importance since Prof. T. P. Hilditch is no longer at work at Liverpool.

Measurements of molecular weights necessarily enter into many of these studies. The methods employed involve measurements of osmotic pressure, boiling point, light-scattering effects and viscosity. By the use of new membranes such as those prepared from polyvinyl alcohol, the lower limit of molecular weight determinable by osmometry has been brought down to about 1,000.

Film formation from a variety of media has been studied by measurements of oxygen uptake and by examination of the products formed. Part of this study is concerned with the drying of films under adverse conditions, such as industrial pollution, tropical humidity or low temperatures.

Linoleum manufacture is akin to paint manufacture in that it involves the oxidation and polymerization of linseed oil. The chemistry of these changes has been considerably clarified by the application of such techniques as solvent fractionation, molecular distillation, infra-red and ultra-violet spectroscopy.

Colour and opacity form the main basis for the commercial evaluation of many pigments. While the Station must necessarily measure these properties, the work on pigments has been carried much further than is required for mere description. Particle-size, shape and distribution are important factors in pigment studies, and their measurement calls for various physical techniques, of which the most attractive is electron microscopy. The original home-made electron microscope—believed to be the second made in Britain, and in the early days of the War—is still in use. Crystal structure factors are examined by electron diffraction and X-ray analysis. The useful concept of 'specific surface'—the surface area per unit weight of powders—is being brought to its full significance for pigments. The values obtained vary from 20-900 sq. m. per gm. for carbon black to 0.5-2.0 sq. m. per gm. for barytes. The wetting and dispersion characteristics of pigments also have not been neglected.

Synthetic resin latex paints are a fairly recent introduction to the industry. To-day their use is widespread and well established; the medium employed consists of a highly viscous dispersed material in the form of swollen particles, and its study calls for new methods of approach involving problems in rheology, storage stability, permeability, inflammability and exterior durability. The nature of the pigment distribution, the structure of the film and the effects of plasticizers in such paints have been studied by various methods, including the application of radioactive tracers and the electron microscope.

Paint utilization involves the relationship between the paint film and the surface on which it is applied. Flexibility, hardness, adhesion and other mechanical properties of films are dependent on their molecular

and internal macro structure. Adhesion studies are carried out in gravitational fields produced by specially designed rotor apparatus, and with other equipment. The understanding of adhesion is not easy; both chemical and physical factors are involved, and a condition called mechanical adhesion seems to be dependent on the ability of a paint film to enter grooves and other deformities in the substrate. The Research Station is hopeful of making some new and significant contributions in this field.

Durability of paint in its many uses is the thing that matters to the customer. To anticipate the behaviour of paint in the sense of accurately forecasting its likely behaviour in various environments is still a dream; but the Research Station has for many years put a big effort into the study of accelerated testing procedures. The current approach is to utilize the results of testing the mechanical properties of films (tensile strength, flexibility, creep, recovery, etc.) after various periods of ageing or accelerated weathering, in order to show the trend of change and to interpret its meaning in terms of probable ultimate performance. A very interesting device in this section involves the use of measurements of the velocity of sound through paint films to determine Young's modulus.

In these ageing and durability studies, the electron microscope has proved a valuable tool for detecting changes in paint deterioration long before they become visible to the naked eye. Stains on painted surfaces, mould growth, paint inclusions, paint deposits, and the effects of atmospheric pollution all call for special techniques, many of which involve microchemistry. These specialized analytical methods, including the direct determination of organic oxygen by Unterzaucher's method, the utilization of ion exchange resins and colorimetry are features of the work of the Analytical Chemistry Section at Teddington.

The Library of the Station deserves mention for its unique collection of specialized books and journals dealing with paint, and for the information, loan and abstract review services which have been organized for its members. How much the Paint Research Station is valued by the trade is proved by the fact that members went there on more than four hundred occasions during 1954.

The results of the application of science to the paint industry are about us all to-day in our homes; a short visit to this Station will soon convince anyone that this chapter is not a closed one—only the opening paragraphs have as yet been written.

W. D. R.

ZOOLOGICAL SOCIETY OF LONDON

EXHIBITION OF WHALES AND WHALING

By DR. L. HARRISON MATTHEWS, F.R.S.

Director

ON May 23 an exhibition of unusual scope was opened by H.E. the Ambassador of Norway, Mr. Preben Prebensen, in the gardens of the Zoological Society of London.

Whales are of great interest to the zoologist by reason of their many peculiarities of structure and ways of life. They are of great economic importance

for the valuable products that are obtained from them. But to the general public they are particularly striking by reason of their enormous size. They are the largest mammals in the world and the largest animals that have ever existed. Once or twice in the past the Zoological Society has attempted to exhibit alive the smallest of the whales—the porpoises and dolphins—but it can, of course, never hope to show the larger kinds in captivity. The next best thing is to exhibit accurate replicas, and the Society was therefore delighted to seize the opportunity of showing the impressive model of a sperm whale's head used in making some of the scenes in Moulin Productions' film of Herman Melville's book, "Moby Dick". Around this centrepiece a number of photographs and other exhibits have been grouped to illustrate the natural history of whales and the history and methods of the whaling industry.

Open-boat whaling for sperm whales began some 250 years ago on the New England coasts of America, and by the middle of the past century no less than 735 American whalers were at sea. Many of these ships completed their crews with sailors from the Portuguese Atlantic islands, the Azores, Madeira and the Cape Verdes. Then there came a decline in sperm whaling after the introduction of paraffin for lighting—a new American industry killed the old one.

But besides the sperm whale there are other great whales—the baleen whales that have no teeth like the sperm whale but instead have numerous plates of whalebone that form a strainer in the mouth which is used for filtering out the shrimp-like krill on which these monsters feed. Their oil, too, is different from sperm oil and can be used for many other purposes, such as making soap and margarine. But they cannot be caught with hand harpoons, for they are extremely active and they sink when dead and would drag down any boat rash enough to harpoon them. They were therefore safe from whalers until about 1860, when the Norwegian Svend Foyn invented the modern whale cannon which is mounted on a small steamship and fires an explosive harpoon that kills the whale. The harpoon is attached to a rope stout enough to haul the dead whale to the surface. The great whaling industry of the Antarctic is based on Svend Foyn's invention and it produces some two million barrels of oil every year.

But the old-time methods are not yet dead; sperm whaling from open boats is still carried on in the Azores and Madeira by men who are the descendants of the Portuguese sailors who learned their trade in the American whale ships more than a century ago.

In addition to the model, which is slightly larger than life size, the exhibition includes an exact replica of a whale boat of the period 1842–48 with all its gear, and a replica of part of the deck of a whale ship of the same period, with the try-works used in boiling the oil out of the blubber. Much historical research has been devoted to obtaining information for use in the construction of these exhibits and every detail is believed to be correct. In contrast to these, a modern whaling cannon and harpoon, and flensing knives, give some idea of the present-day highly organized Antarctic whaling industry.

The photographs show several species of whales, the giant squids that form the food of sperm whales, and the Euphausian 'krill' forming that of the baleen whales. Another series of enlargements shows many stages in the hunting and capture of whales and the utilization of their carcasses by the floating factories in the Antarctic. These are set off by a number of

stills from a film showing the hunting and capture of sperm whales from open boats with hand harpoons at the present day off the Azores and Madeira.

The inauguration was assisted by H.E. the Portuguese Ambassador, Dr. Pedro T. Pereira, one of the few diplomatists who has had personal experience of whaling. He is the holder of a coastal master's certificate and is a member of the Portuguese Naval Reserve.

Mr. Preben Prebensen, the Norwegian Ambassador, in declaring the exhibition open, said that he welcomed the opportunity it provided for the public to learn something of a most important industry in which his country took a leading part, an industry of great magnitude of which, however, little detail is known to the vast majority of people.

OBSERVATIONS ON HEAVY MESONS AND HYPERONS

FOR more than two years it has been known that heavy mesons and hyperons exist with a variety of modes of decay, and one of the central problems of the physics of elementary particles has been to establish the details of their properties. A list of transformations which are well established, or for which there is strong evidence, is shown in Table 1. As the work has progressed, it has appeared increasingly important to establish whether or not other differences exist between the properties of heavy mesons decaying in different modes. The existence of a small difference of mass, for example, if it could be established, would exclude the possibility that the particles represent alternative modes of decay of particles of a single type.

Table 1

Modes of decay of heavy mesons

$$\begin{aligned}\tau^\pm &\rightarrow \pi^\pm + \pi^+ + \pi^- \\ \tau^+ &\rightarrow \pi^\pm + (\pi^0 + \pi^0) \\ \kappa^+ &\rightarrow \mu^+ + 2 \text{ or more neutrals} \\ \chi^+ &\rightarrow \pi^+ + \pi^0 \\ K_\mu &\rightarrow \mu^+ + \nu^0 \\ K_\beta &\rightarrow \beta^+ + 2 \text{ or more neutrals} \\ \theta^0 &\rightarrow \pi^+ + \pi^-\end{aligned}$$

The mass of the τ -meson is $966 \pm 3 m_e$, assuming $m_\pi = 273 m_e$. The masses of particles decaying in the modes θ^0 , χ and κ_μ are equal to m_τ within about 20 m_e .

Masses and modes of decay of hyperons

$$\begin{aligned}\Lambda^0 &\rightarrow p + \pi^- & 2,181 \pm 1 m_e \\ \Sigma^+ &\rightarrow p + \pi^0 \\ &\rightarrow n + \pi^+ & \left. \begin{array}{l} 2,327 \pm 3 m_e \\ 2,540 \pm 30 m_e \end{array} \right\} \\ \Sigma^- &\rightarrow n + \pi^- \\ \Xi^- &\rightarrow \Lambda^0 + \pi^-\end{aligned}$$

During this period it has become apparent that, in using the photographic method for such studies, there would be great advantages in employing very large stacks of stripped emulsions. It was believed, for example, that they would permit a large fraction of the secondary particles to be observed to the end of their range, thus giving decisive evidence for the nature of the secondaries. This would permit a determination of the relative frequency of occurrence

of different modes. Further, very accurate values of the energy of emission of the secondary particles could be obtained, and for those modes in which there are two secondary particles only, accurate determinations of the mass would follow.

The technical problems involved in processing very large stacks of emulsions—and in making balloon flights with heavy loads at great altitudes—having been overcome, a stack with a volume of 15 litres, mass 62 kgm., was exposed in Northern Italy in early October 1954, in a collaboration between the Universities of Bristol, Milan and Padua. It is referred to as the *G*-stack, and its dimensions—37 cm. $\times$ 27 cm. $\times$ 15 cm., made up of 250 sheets of emulsion, 600 μ thick—were chosen to ensure that a considerable fraction of the secondary particles, even those of range about 20 cm., would be arrested in the stack.

The balloon was launched from Novi Ligure, and floated at an altitude between 85,000 ft. and 78,000 ft. for six hours. During the ascent, it travelled towards the south-west and passed beyond the coast and over the Gulf of Genoa. On reaching its maximum altitude it moved slowly eastward, and at the time of 'cut-off' it was over the Central Apennines near Berceto. Through a partial failure of the parachute, the stack sustained some damage from impact of the equipment with the ground, and about 10 per cent of the emulsion was destroyed.

After processing, the stack was divided among the Bristol, Milan and Padova groups; and among workers in the Universities of Brussels and Genoa, in the University College and the Institute for Advanced Studies, Dublin, and in the Institute for Theoretical Physics, Copenhagen. During the first four months spent on the examination of the plates, about 400 *K*- and *Y*-particles have been found, and it is now known that the total number of such particles recorded in the stack is of the order of 80,000. It appears certain that the potentialities of the method will be fully realized; it will be possible, for example, to make very accurate measurements of the masses of the heavy mesons and hyperons, and to determine the relative frequency of occurrence of particles decaying in different modes. Values of the highest precision will depend, however, on observing a sufficiently large number of stopping secondary particles to ensure that the errors due to straggling are small, and on a verification of the range-energy relation in the high-energy region.

The most important of the results obtained hitherto are summarized below. They are based on the measurements of the first observed secondary particles with a long path-length in the stack. In determining the energy of a meson from its observed range, the range-energy relation of Baroni *et al.*¹ has been employed. It has also been assumed that for a particle of energy ~ 100 MeV. the value of the energy for a given range may be in error by about ± 1.5 per cent.

Decay of *K*-Mesons

Most of the secondary particles observed hitherto in the *G*-stack have energies of emission corresponding to the modes of decay referred to as χ and K_μ , respectively.

(a) *The χ -mode.* The χ -meson was originally defined² as a heavy meson which, when it decays at rest, emits a charged π -meson with an energy of 116 ± 5 MeV., and a single neutral particle; the

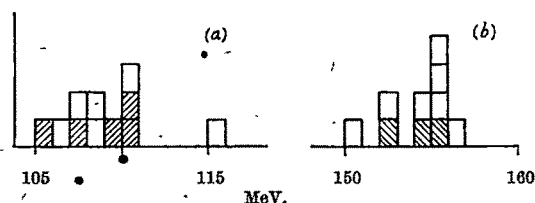


Fig. 1. Shaded areas correspond to particles arrested in the emulsion

rest-mass of the neutral particle was believed to be less than $300 m_e$. The accumulation of evidence from experiments with plates and Wilson chambers has shown that the transformation proceeds according to the equation, $\chi^+ \rightarrow \pi^+ + \pi^0 + Q$, the kinetic energy of the charged π -meson being about 108 MeV.; it follows that the mass of the particles decaying in the χ -mode is, if at all, very little different from that of the τ -meson.

In a group of twelve secondary particles observed in the G -stack which can be attributed with confidence to the χ -mode, there are five examples in which the secondary particle stops in the stack and shows the characteristic transformation $\pi \rightarrow \mu \rightarrow e$. The ranges of these particles all fall in the interval between 11.2 and 12.0 cm., and the mean value is 11.71 ± 0.25 cm. The corresponding value of the energy is 108.4 ± 3 MeV. (see Fig. 1)—very close to that given by the early estimates—and of the mass of the parent meson, $966 \pm 12 m_e$. It may be emphasized that it will be possible to reduce the errors greatly by accurate measurements on the range-energy relation, and by attention to various possible sources of small systematic errors.

In seven events of a similar character, the secondary π -meson fails to reach the end of its range through interacting with a nucleus, or because it leaves the stack. In such cases, the velocity of the particle near the point where the track terminates can be determined by grain-counts or scattering observations, and then the corresponding value of the residual range. The values of the initial range of the π -meson thus determined are frequently only a little less accurate than those in which the full range is observed (see Fig. 1 a).

In one of the examples of the χ -mode of decay, the tracks of two electrons, which form a close pair of total energy ~ 116 MeV., are observed together with the charged π -meson. These electrons are ejected in a direction making $\sim 46^\circ$ with the line of motion of a particle recoiling from the charged π -meson. This event appears to be the first example of the χ -mode observed hitherto, in which the secondary π^0 -meson decays in the alternative mode: $\pi^0 \rightarrow \gamma + (\beta^+ + \beta^-)$.

(b) *Mode of decay $K_\mu \rightarrow \mu + \nu$.* The first evidence for the existence of this mode³ suggested that the particle decays into a μ -meson of unique energy and one neutral particle, probably a neutrino. Its mass was given as $914 \pm 20 m_e$. Later work with Wilson chambers has supported the original evidence for the mode of decay, $K_\mu \rightarrow \mu + \nu + Q$, and the most recently determined values of the mass are $941 \pm 17 m_e$ ⁴ and $950 \pm 15 m_e$ ⁵.

Twelve secondary particles have been observed in the G -stack, which can be attributed to the decay mode K_μ (see Fig. 1 b). Three of them stop in the stack and their ranges are 20.17 ± 0.45 cm., 20.47 ± 0.45 cm. and 20.67 ± 0.45 cm. The corresponding value of the mean energy of emission is $E_\mu = 154 \pm$

4 MeV., and the mass, assuming the particle transforms according to equation (2), is $971 \pm 15 m_e$, the Q -value being 390.5 ± 9 MeV. In the remaining nine events also, the values of $p\beta$ as determined by scattering measurements are consistent with those given by range (see Fig. 1 b).

(c) *Other modes of decay.* Of the other established modes of decay of heavy mesons, twenty examples of the τ -mode have been found, five examples of the τ' -mode, two examples of the χ -mode in which the secondary μ -meson is observed to stop and decay, and one example of the mode $K\beta$.

It is very important to determine the relative frequency of occurrence of the various modes of decay as observed in a wide range of experimental conditions, for any differences would furnish proof for the presence of different types of particles among the K -mesons.

It has not yet been possible to make a precise estimate of the relative frequency occurring in the present experiments, but it appears certain that the χ mode is infrequent compared with χ and K_μ . A similar remark applies to the mode $K\beta$.

Hyperons

Among many hyperons observed in the stack, there is one example of particular interest in which a charged hyperon comes to rest and decays into a π^+ -meson of range 8.93 ± 0.22 cm., which shows the characteristic transformation $\pi \rightarrow \mu \rightarrow e$. The parent hyperon was therefore positively charged, and the event may be attributed to the transformation, not previously identified, $\Sigma^+ \rightarrow \pi^+ + n + Q$, where n represents a neutron. With this interpretation, the release of energy, Q , is found to be 108.5 ± 3.5 MeV., and the mass of the hyperon, $2,325 \pm 7 m_e$. This value is equal, within the limits of error, to that deduced from observations on the alternative mode, $\Sigma^+ \rightarrow p + \pi^0$; namely, $2,327 \pm 3 m_e$.

Associated Production of Heavy Particles

Observations of the emission from the same nuclear disintegration of a K -meson and a charged hyperon have been reported previously from a number of laboratories. In such events in which the mode of decay could be established, examples have been found in which the K -particle transforms in the τ -mode and probably also in the χ -mode. In the G -stack, a similar example of associated production has been found in which the K -meson decays in the χ -mode. It follows that among the other properties which they have in common, the K -mesons decaying in these three modes may all be produced in association with charged hyperons.

In addition to examples of the 'associated' production of K -mesons and hyperons, an event of particular interest has been observed which appears to represent the 'pair production' of K -mesons. A negative K -meson reaches the end of its range and appears to interact with a proton, according to the equation $K^- + p \rightarrow \Sigma^+ + \pi^-$. On examining the parent 'star' from which the negative K -meson was emitted, it was found that another K -meson had also been ejected. It appears to be significant that in the first ten examples of 'stars' providing evidence of associated production, the heavy particle formed in association with a positive K -meson was always found to be a hyperon, whereas in the first example of a heavy particle formed in association with a K^- -meson, the associated particle was a second

K-meson. This result, if confirmed by observations of greater statistical weight, would provide important support for recent theoretical speculations⁶.

Unstable Nuclear Fragments

Among examples of heavy unstable fragments of the type discovered by Danysz and Pniewski⁷ which are believed to contain Λ^0 -particles, two examples have been found in the *G*-stack which appear to represent ${}^4\text{H}^+$ and ${}^6\text{He}^+$. In the first, the heavy fragment reaches the end of its range and decays into two charged particles which recoil from one another, the two tracks being collinear. Preliminary estimates of the binding energy of ${}^4\text{H}^+$ give the value 1.2 ± 0.8 MeV., close to that for ${}^4\text{He}^+$. It may be remarked that whereas the normal nuclei of both ${}^4\text{H}$ and ${}^6\text{He}$ are highly unstable, the replacement of a neutron by a Λ^0 -particle produces an assembly which is stable up to the instant of decay of the hyperon.

Detailed reports of the observations are to appear in *Nuovo Cimento*.

Baroni, G., Castagnoli, C., Cortini, G., Franzinetti, C. and Manfredini, A., *Bur. Stand., C.E.R.N. Bull.* No. 9 (1954).

Menon, M. G. K., and O'Ceallaigh, C., *Proc. Roy. Soc., A*, 221, 292 (1954).

Gregory, B., Lagarrigue, A., Leprince-Ringuet, L., Muller, F., and Peyrou, C., *Nuovo Cim.*, 11, 292 (1954).

Armenteros, R., Gregory, B., Hendel, A., Lagarrigue, A., Leprince-Ringuet, L., Muller, F., and Peyrou, C., *Nuovo Cim.*, 1, 915 (1955).

Bridge, H. S., De Staebler, Jun., H., Rossi, B., and Sreekantan, B. V., *Nuovo Cim.*, 1, 874 (1955).

Gell-Mann, M., and Pals, A., *Proc. Int. Conf. on Nucl. and Meson Phys.* (Glasgow) 1954; Nishijima, "Prog. Theor. Phys.", 12, 107 (1954).

Danysz, M., and Pniewski, J., *Phil. Mag.*, 44, 348 (1953).

THE EXPOSURE OF THE PILTDOWN FORGERY*

By SIR WILFRID LE GROS CLARK, F.R.S.

THE discovery of parts of a human skull and an ape-like jaw in gravel deposits at Piltdown some forty years ago led many able authorities to the conclusion that they were the remains of a very archaic and lowly type of man, which was given the name *Eoanthropus* (or the 'dawn man'). This interpretation, in the first instance, seemed well assured by statements that some of the remains had been found by recognized authorities *in situ* (that is to say, in hitherto undisturbed gravel), that the skull was of an unusually primitive form, that the jaw (though very ape-like) contained teeth worn flat in human fashion, that the gravel deposit itself—on purely geological evidence and on the evidence of the remains of extinct mammals found therein—was of very ancient origin (at least Early Pleistocene), and that exceptionally crude flint implements were found in the same deposit.

All this evidence has now been shown to be of a fraudulent nature. How came it that the authorities concerned with the initial study of these remains were so completely misled? In my opinion, one of the primary factors was a curious error in the initial reconstruction of the skull. Smith Woodward, who was an established authority on general vertebrate palaeontology (but not himself experienced as a human anatomist), mistook a small side ridge on the

roof of the skull for a median ridge (such as is not uncommon in certain ancient skulls) and as a result his reconstruction of the skull made it appear an unusually primitive type with an unusually small brain. This was quite an excusable error for one not versed in the intimate details of human anatomy; but it undoubtedly misled Elliot Smith, an authority on the anatomy and evolution of the brain, to make a statement, from a study of a cast of the inside of the reconstructed skull, that 'Piltdown Man' possessed the most primitive and most simian human brain so far recorded. This, of course, fitted with the evidence of the ape-like jaw, with the alleged antiquity of the gravel deposits, and with all the other collateral evidence, so that each line of evidence appeared to be entirely corroborated by all the others.

It is true that the late Sir Arthur Keith afterwards demonstrated the error in the initial reconstruction of the skull, and showed that it really belonged to quite a large-brained individual; but this did not arouse suspicions as to the authenticity of the discovery as might have been the case if the first reconstruction had been correct. In any event (as already noted) the 'finds' were made by men of established reputation, so that there was not the slightest reason why the idea of fraud should ever have been entertained by any of the professional scientists who took part in the early discussions. So far as the wear of the teeth is concerned, if there had been any suspicion at all that it was not natural, this suspicion would certainly have been at once dispelled by the statement of the dental surgeon, Dr. A. S. Underwood, that the worn surface of the canine tooth showed an exposure of 'secondary dentine' (which is normally produced as a reaction to severe natural wear). Thus the evidence of each expert seemed to be in such complete harmony with that of the others that none of them was led to examine his own evidence as critically as otherwise he certainly would have done.

The demonstration by Dr. K. P. Oakley on the basis of fluorine analysis in 1950 that the Piltdown remains were not nearly so ancient as had been supposed was the real starting point for a new inquiry, for it seemed impossible to suppose that such a primitive type as 'Piltdown man' could have existed in Sussex right at the end of the Ice Age (particularly as it was completely out of accord with all the other fossil evidence relating to human evolution which had since accumulated). The sinister proposition then presented itself—even if the skull itself was a genuine fossil indigenous to the Piltdown gravels, could the jaw be that of a modern ape which had been deliberately faked to simulate a fossil specimen and inserted into the gravel so as to appear a truly '*in situ*' specimen?

The main objection to this hypothesis appeared to be the flat wear of the molar teeth, a type of wear which is never found in modern apes at an equivalent stage of attrition. It was at this point that Dr. Weiner demonstrated that by filing down the molar teeth in a modern ape's jaw it was quite easy to produce an appearance astonishingly like that of the Piltdown teeth. As a result of this experiment, the Piltdown teeth were re-examined in much greater detail, and it at once became evident that they showed very definite signs of artificial abrasion. Indeed, it was these anatomical observations which led to further investigations by drilling out adequate samples of the jaw material for chemical analysis (a procedure which quite naturally had not been done

* Substance of a Friday Evening Discourse at the Royal Institution on May 20.

before for fear of mutilating what was presumed to be an absolutely unique specimen). The chemical and spectrographic analyses demonstrated beyond doubt that the jaw was a modern jaw which had been deliberately stained with iron and chromate salts to match the discoloration to be expected for fossils in the Piltown gravels.

At this stage, we did not suspect that the other finds at Piltown might also have been fraudulent. But our discovery of the fraudulent nature of the jaw led to an intensive study of all the other Piltown finds, with the startling result that every one of them proved to have been 'planted' in order (evidently) to provide a complex framework of complementary evidence for the supposed antiquity of the skull and jaw. The so-called 'secondary dentine' in the canine tooth was found to be a plastic material (probably Vandyke brown paint) which had served to plug an opening inadvertently made into the pulp cavity during the process of artificial abrasion, the skull bones had been artificially stained, the geological evidence for the supposed antiquity of the Piltown gravels was shown to be faulty, the remains of extinct mammals reputed to have come from the gravels had obviously been derived from other sources, and, finally, the acidity of the gravels was found to be such that it was difficult to suppose that any bony remains deposited in them would have been preserved for any considerable length of time.

The flint implements also showed conclusive evidence of having been artificially stained to match the deposits in which they were alleged to have been discovered. The forger had certainly shown considerable skill in forging his evidence, but he also made some serious mistakes—particularly by overdoing some of the faking. A professional anatomist, for example, could have faked the teeth much more skilfully; but, even so, the modern methods of detection now developed could easily have exposed the fake. It is only fair to the original investigators of 'Piltown man' to point out that if these modern methods had been available forty years ago, they themselves would not have been misled in the way they were. The fact is that the investigation of the Piltown remains, altogether apart from the exposure of a remarkable forgery, has proved a most profitable investigation, for it has led to the development and perfection of a whole battery of techniques which will not only make it virtually impossible for anyone to repeat such a deception, but which will in the future be of the greatest use in estimating the antiquity of genuine fossils.

OBITUARIES

Dr. Thomas Royds

DR. THOMAS ROYDS died after a short illness on May 1 at Southport at the age of seventy-one. He was born at Oldham on April 11, 1884. He studied physics at the University of Manchester under Schuster and Rutherford, working especially on the constitution of the electric spark and on the spectrum of radon and the identification of α -particles as helium atoms. With an 1851 Exhibition he went to Germany, carrying out infra-red spectroscopy under Paschen in Tübingen and Rubens in Berlin. He graduated as doctor of science in Manchester in 1912.

Royds had therefore a wide knowledge and experience of spectroscopic technique when he was

appointed assistant director of Kodaikanal Observatory in India in 1911. He remained there until 1939, succeeding Mr. J. Evershed as director in 1923. Here the major part of his scientific work was done. It fell into two main sections. Exact measurements were made of the wave-lengths of lines in the solar spectrum and in the electric arc under varying conditions, to study the causes of observed displacements. Perhaps his most important contribution in this subject was his measurements of the displacements of lines to the red at the extreme limb of the sun, as studied at the total eclipse which he observed at Kamishari in the island of Hokkaido on June 19, 1936. He found that differences of shift for lines of different intensity, such as had been observed without eclipse, were maintained right up to totality and could not be ascribed to scattered light from the centre of the disk. Relativity theory was not adequate to give a complete explanation of the displacements observed. His other investigations at Kodaikanal were largely concerned with dark markings given by spectroheliograms of the sun's disk, their distribution, motions and progressive changes of inclination to the solar meridians. Other studies were made on prominences, unusual bright filaments, radiation pressure and oxygen in the chromosphere.

On his retirement from Kodaikanal, Royds went to live at Southport; but in 1942 he accepted an invitation to go to Istanbul as professor of astronomy, having to travel there by sea around the Cape under war-time conditions. He learnt in a few months to lecture in Turkish and remained in Istanbul until 1947, when he finally retired. He leaves a widow, two daughters and a son. F. J. M. STRATTON

Dr. G. H. Miles

GEORGE HERBERT MILES, a former director of the National Institute of Industrial Psychology, died on April 4, at the age of seventy-four.

The son of a Sussex village schoolmaster who delighted in making electrical gadgets, he followed quickly and closely in his father's footsteps. He became a teacher at the age of seventeen, and at twenty entered the Westminster Training College. Here he had his introduction to psychology; and his interest in it led him, when he had secured another teaching appointment, in Hull, to study the subject (together with physics and physiology) for a London external degree. Lacking facilities for instruction in psychology and physiology, he made his own apparatus and conducted his own courses in the practical work required. His examiners, who included Sherrington and Leonard Hill, seemed satisfied.

The inventiveness and self-reliance suggested by Miles's achievements in these early years were characteristic of him throughout his life. But they were combined with some ambivalence in his attitude to science on one hand and industry on the other. That he was capable of good scientific work was clear from his D.Sc. thesis, on immediate visual memory; but at the same time he had a strong desire to be 'practical', and an inclination to be highly critical of academics. It is significant, perhaps that in his autobiography (*Occupational Psychology*, 23, 193, and 24, 31) he records a remark made to him by Munsterberg, whom he visited at Harvard in his late twenties: "I am glad you came to see me. What psychology wants now is the middleman".

A middleman he became. After service in the Royal Navy during the First World War, which gave him

still further chances of displaying his talent for invention, he gave up the headmastership of a new grammar school in North Yorkshire to join Dr. C. S. Myers and Mr. H. J. Welch in forming the National Institute of Industrial Psychology. He was appointed secretary, with his sister, Miss M. A. Miles, as his assistant. His wife, who survives him, approved this typically bold step, despite the fact that his salary was to be meagre and could not be assured for more than one year. Later, when Myers became principal, Miles succeeded him as director; and in that capacity he governed the organization, in its everyday affairs, until he was informed, in 1936, of the impending appointment of a general director, whose task was

to rescue the Institute from financial difficulty. He promptly resigned.

Miles kept up his early interests to the very end, and in his last years he was engrossed in the perfecting of devices for the better training of drivers and pilots. He did it all with almost boyish enthusiasm, with tremendous persistence, and with genuine diffidence and modesty. He was adventurous and without fear, and he cared not at all for time. Those who have read his lively autobiography, and who have felt exasperated by the fact that it has scarcely a date in it, will not be surprised to learn that he never carried a watch.

ALCO RODGER

NEWS and VIEWS

The Earl of Iveagh, K.G.

LORD IVEAGH, who has recently been appointed a Knight of the Garter, has been a generous and enlightened patron of science and has himself contributed not a little to our knowledge of such subjects as soil fertility and diseases of animals. As a young man he was attracted to medicine. He persuaded his father to endow the Lister Institute and encouraged the work of two brilliant young scientists, who afterwards became famous as Sir Almroth Wright and Sir Alexander Fleming, and who were then conducting experiments in the Inoculation Department of St. Mary's Hospital, Paddington. This association led to the setting-up of the Wright-Fleming Institute of Microbiology with Lord Iveagh as its chairman. In 1929 he subscribed £40,000 to enable the Institute to extend its laboratories.

In 1912, after discussions with Sir John Russell, head of Rothamsted Experimental Station, and Almroth Wright, he offered to finance an investigation on modern biochemical lines into the making, storage and use of farmyard manure. He placed his own farm in Surrey at the disposal of the investigators and assisted with the work himself. The results were highly successful and revealed the principle involved in the making of composts. A further discovery, which he made himself, was that the marsh gas given off by vegetation fermenting in stagnant water and known to country people as 'will-o'-the-wisp' could be produced artificially from straw or manure and used for heating or lighting. Lord Iveagh next turned his attention to the bacteriological content of milk from cows and was one of the pioneers in evolving modern methods of sterilizing the production process. He also played a leading part in the early experiments for eradicating tuberculosis from dairy herds and discovering treatment for mastitis and contagious abortion, in which he worked closely with Dr. John Hammond, of Cambridge. When the National Institute for Research in Dairying was looking for a home, he helped to finance the purchase of its present premises at Shinfield, and contributed money to erect new laboratories and buildings. Since 1920 he has been chairman of its governing body. A life-long believer in the benefits which science can confer on the community, Lord Iveagh has used his wealth, not only to assist original research, but also to demonstrate by his own example as a practising and successful farmer the revolutionary improvements which can be brought about by the use of scientific methods.

College of Aeronautics: Prof. G. A. Whitfield

MR. G. A. WHITFIELD, who has been appointed professor and head of the new Department of Aircraft Electrical Engineering in the College of Aeronautics, Cranfield, was educated at Bede School, Sunderland, and at the University of Sheffield, where he graduated with special honours in physics in 1937. He joined the Royal Aircraft Establishment, Farnborough, and then worked on the development of bomb sights and automatic pilots; in the following year he went to the Research Department, Exeter, where he worked until 1943 on the development of proximity fuzes for bombs. His work in this field was recognized recently by an award made by the Royal Commission on Awards to Inventors. In 1943 Mr. Whitfield went to the Marine Aircraft Experimental Establishment to take charge of the research station at Glen Fruin for investigations into the underwater behaviour of anti-submarine weapons. In 1945 he returned to the Royal Aircraft Establishment to form a group for research into the control of guided missiles. In this field he made important contributions, particularly to the design of control systems in the presence of 'noise'. He was promoted to the rank of senior principal scientific officer in 1950 as head of the Armament Control Division of the Armament Department, where he has been responsible for the development of a wide range of sighting and fuzing devices.

Victoria University College, New Zealand:

Prof. Darcy Walker

DR. DARCY WALKER has been appointed to the chair of physics at Victoria University College, New Zealand, in succession to Prof. C. N. Watson-Munro (see *Nature*, 174, 1085; 1954). Dr. Walker was born at Palmerston North, New Zealand, and educated at the Palmerston North Boys' High School and at Auckland University College. After graduation, he entered the service of the New Zealand Department of Scientific and Industrial Research and was initially engaged on meteorological work; but during the War he was employed upon defence work that took him both to the United States and to the United Kingdom. In 1945, Dr. Walker joined Prof. M. L. Oliphant at Birmingham, obtaining the degree of Ph.D. for his work on short-lived nuclear isomers, and holding in succession various research fellowships. He spent two years, 1949-51, at Cornell University and the University of California as a Commonwealth Fund Fellow, working on the nuclear

photo-effect and on meson production in the region of 300 MeV. More recently still, he has been responsible for studies of nuclear cross-sections with protons accelerated by the Birmingham synchrotron. He has taken a leading part in elucidating the mechanism by which multiply-charged ions of nitrogen, oxygen, etc., are accelerated in the cyclotron, in studying nuclear reactions produced by them, and in investigations of charge-exchange phenomena when these heavy ions pass through matter. Dr. Walker will thus take to Victoria College a wide experience of physics gained in various countries.

University College of Rhodesia and Nyasaland:

Prof. A. G. Davis

THE chair of agriculture at the newly established University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia, is to be filled by Mr. A. G. Davis, reader in agronomy at Wye College, University of London. A Canadian by birth, Mr. Davis commenced his training at the Ontario Agricultural College at Guelph, where he specialized in crop husbandry, graduating in 1936. His interest in grassland developed early and took him to the Welsh Plant Breeding Station in 1936 to undertake research on pasture mixtures, for which he was awarded the M.Sc. degree of the University of Wales two years later. He was then appointed assistant agronomist at the Station and joined the team of Sir George Stapledon and Dr. William Davies in the Grassland Survey of England and Wales, 1939. Afterwards, Mr. Davis became agronomist at the Grassland Improvement Station at Stratford-on-Avon and then head of the Herbage Agronomy Department. During this period he was responsible for many agronomic trials and published a number of papers relating to the growing of grass, clover and lucerne. In 1949 Mr. Davis was appointed lecturer in agriculture (grassland husbandry) at Wye College and became in turn senior lecturer and then reader in agronomy. He has served the University of London as an examiner in agriculture and as a member of the Board of Studies in Agriculture and Horticulture. His experience in field-work, in university administration and in directing the research of postgraduate students makes him well fitted to develop a vigorous Department of Agriculture in the new University College.

Prof. S. H. Harper

DR. STANLEY H. HARPER has been appointed the first occupant of the chair of chemistry in the new University College. Dr. Harper was educated at Varndean School and at the Imperial College of Science and Technology, London, where he was awarded the degrees of B.Sc., Ph.D. After holding demonstratorships at the Imperial College and at Birkbeck College, London, he proceeded to the University of Manchester as research assistant and then in 1937 joined the staff at the Rothamsted Experimental Station to work on the chemistry of naturally occurring insecticides. He gained a London D.Sc. in 1943. In 1942 he returned to university teaching, successively occupying posts of lecturer and senior lecturer at University College (as it then was), Southampton, and is at present reader in organic chemistry at King's College, London. Dr. Harper is known for his contributions to research in organic chemistry on the synthesis of Diels's hydrocarbon (with the late Prof. G. A. R. Kon), the constituents of derris and pyrethrum, the synthesis of the pyrethrins, and the stereochemistry of olefinic

compounds. He has published some sixty papers, mainly in the *Journal of the Chemical Society*; he is at present chairman of the Publication Sub-Committee of the Society of Chemical Industry.

Proposed Television Tower for Belgium

IT is now well established that in order to provide a large area for the satisfactory reception of television the transmitting aerial must be erected as high as possible above the surrounding terrain. Belgium, which has so far engaged in television only on an experimental basis, intends to exploit this technical requirement to the greatest practicable extent. During a recent visit to London, the Belgian Minister of Communications, M. Edouard Anseele, said that it is intended to build the highest television tower in the world at the site of the international exhibition to be opened in Brussels in 1958. The main portion of the tower, which will be built of concrete, will be in the form of a truncated cone, 450 m. high; and this will be surmounted by a cylindrical structure of ten stories with provision for technical services and a restaurant. On top of this will be mounted the television antenna structure at a maximum height of 635 m. above the ground. This is more than twice the height of the Eiffel Tower, which is about 300 m.

Status of Technical College Students

MR. S. RUBINSTEIN's presidential address to the Association of Teachers in Technical Institutions, delivered on May 29, welcomes the withdrawal by Sir David Eccles of Circulars 242 and 245 relating to economy in education and new building; but in regard to the latest award on special allowances, he urges that what is needed is an increase in all scales to attract in sufficient numbers the teachers of quality essential for a first-rate public educational service. He regards the range of 15-25 per cent of grammar school and technical school places as meaning a grave limitation of opportunity for children; in regard to technological education, he claims that the 4,736 full-time students doing advanced work in major technical colleges for university courses and 6,140 students in non-university classes, with 6,433 and 26,098 part-time students, represent a contribution comparable with the 29,273 full-time and 816 part-time university students in science, technology and agriculture. He also urges that there is little reason for any differentiation in grants to students between the technical colleges and the universities. Speaking of the curriculum in technical education, Mr. Rubinstein emphasized that any one-sided form of education is undesirable. Both science and the humanities are necessary to comprehend the world: the arts student should have some knowledge of science and of scientific method, and the technical student should be reasonably well informed on matters such as literature, economics and the current clash of ideas which go to make up the pattern of society.

Geological Collection for the University of Sheffield

THE Department of Geology of the University of Sheffield has recently received an exceptionally valuable collection of minerals from Mr. A. W. G. Kingsbury. The basis of the collection includes specimens from three famous mineral collections—those of Thomas Kingsbury (1777-1854), Lord Shuttleworth of Burnley and Baroness Burdett-Coutts—to which have been added specimens by Mr. Kingsbury himself. It contains some five

hundred specimens of important minerals, all of which are perfect examples and many are extremely rare. Each specimen is accurately named and localized. The collection will be known as the A. W. Kingsbury Collection of Minerals; part will be on permanent display and the remainder made available for the use of students and interested persons in accordance with the wishes of the donor.

Journal of Inorganic and Nuclear Chemistry

THE first number of a new *Journal of Inorganic and Nuclear Chemistry*, published by the Pergamon Press, of London and New York, appeared in March (pp. 164). The subscription per volume (six numbers) is 90s. (12.60 dollars) or, for individual subscribers certifying that the journal is for their private use, 70s. (9.80 dollars). The editors are J. J. Katz (Chicago), H. C. Longuet-Higgins (Cambridge) and H. A. A. McKay (Harwell), and there is an international editorial advisory board. The *Journal*, which has the support of many distinguished chemists, is intended to be international in character and will publish papers of the necessary standard from any source. The first number has made a good start. It contains papers from the United States, Great Britain, France, Germany and Sweden, all of which are of a high standard.

Periodicity of Spore Discharge in an Ascomycete

C. T. Ingold and V. J. Cox (*Ann. Bot.*, N.S., 19, 74, 201; 1955) have discussed this phenomenon in the light of experimental investigations. In *Daldinia concentrica* spore discharge under natural conditions is periodic, most spores being discharged during the night and few in the daytime. An experimental study was made of discharge under controlled conditions of light and temperature. In continuous darkness periodic discharge was maintained for twelve days; but then, although spore output continued, it ceased to be periodic. Return to alternating light (12 hr., 100 foot-candles) and darkness (12 hr.) at once re-established the periodicity. In continuous light (100 foot-candles) periodic discharge ceased after 2-3 days, but was immediately re-established in alternating light (12 hr.) and darkness (12 hr.). When the fungus was placed under conditions of alternating light and darkness each of six hours duration, two peaks of spore-output were soon developed in the 24-hr. period. The experiments suggest that the natural periodicity is determined by the alternation of day and night.

The Mithras Head of the City of London

IN the April number of the *Museums Journal*, Dr. H. J. Plenderleith, of the British Museum Laboratory, describes the treatment and restoration of the marble head of Mithras found in the City of London during excavations in the Walbrook Mithraeum. The head came from a moist clayey site, was in a damp and muddy condition and bore a dark granular incrustation of iron compounds. The stone was found to be weakened by a form of sugary decomposition which might have resulted from intense heat. The marble was allowed to dry out and much of the incrustation was removed by pointed matchsticks. Sequestration of the iron was carried out by using 'Versenol' as a complexing agent. The sugary areas of the marble were treated by applications of lime water which, in time, filled the pores of the stone with carbonate of lime. Finally, two coats of soluble 10 per cent casein were applied which had a marked

effect in reinforcing the surface. This meticulous work was carried out in the British Museum Laboratory, and details of the process are given in the paper quoted.

Royal Society and Nuffield Foundation Commonwealth Fellowships

AWARDS under the Royal Society and Nuffield Foundation Commonwealth bursaries scheme have been announced as follows: Prof. N. P. Badenhuizen, professor of botany, University of the Witwatersrand, to enable him to study the application of radioactive isotopes to problems of starch granule growth, at the Postgraduate Medical School, London (September-November 1955); Mr. D. H. Colless, lecturer in parasitology, University of Malaya, to enable him to study mosquito collections at the British Museum (Natural History) and elsewhere to solve certain problems in Culicine systematics (July-December 1955); Dr. M. Davies, senior lecturer in chemistry, University College of Wales, Aberystwyth, to enable him to visit Sydney (January-September 1956) to work in the field of molecular structure, infra-red spectroscopy and dielectric absorption; Dr. A. A. Kinnear, Institute for Pathology, University of Pretoria, to enable him to study endocrinological techniques at Birmingham (July-September 1955); Dr. J. H. D. Miller, consulting neurologist, Royal Victoria Hospital, Belfast, to enable him to study electrocorticography at the Montreal Neurological Institute (September-November 1955); Prof. S. R. Palit, Indian Association for the Cultivation of Science, Calcutta, to enable him to study the use of radioactive compounds and photochemical techniques in polymerization at Birmingham and other centres in Great Britain (July-August 1955); Prof. M. Sharif, professor of zoology, University of the Punjab, Lahore, to enable him to study ecological and insecticidal techniques practised at the London School of Hygiene and Tropical Medicine (July-September 1955); Prof. P. A. Sheppard, professor of meteorology, Imperial College of Science and Technology, to enable him to visit Melbourne and Sydney (September 1955-January 1956) for investigation of the interaction between atmosphere and ocean in relation to the general circulation of the atmosphere; Prof. J. B. Warren, Physics Department, University of British Columbia, to enable him to visit Canberra (August 1955-August 1956) to study the photodisintegration of nuclei. This is the third group of awards under the scheme which was instituted in 1953 to provide facilities for increasing the efficiency of scientists of proved ability by enabling them to pursue research, learn techniques or follow other forms of study in natural science in countries other than their own in the Commonwealth where the physical or personal environment, or both, are peculiarly favourable.

Leverhulme Research Awards, 1955

THE following Leverhulme Research Awards, among others, have been made for work on the subjects indicated. *Fellowships*: R. B. Benson (principal scientific officer, Department of Entomology, British Museum (Natural History)), comparison of the northern sawfly fauna of Canada with that of Europe; Dr. H. O. Foulkes (senior lecturer in pure mathematics, University College, Swansea), symmetric functions and group theory; Prof. C. F. C. Hawkes (professor of European archaeology, University of Oxford), the Mediterranean relations of

trans-Alpine and Western Europe, 1400–400 B.C.; Miss P. M. Kemp (formerly lecturer, University of Allahabad), household economy and technology of some tribal communities in the Punjab; Dr. P. F. R. Venables (principal, Royal Technical College, Salford), training schemes in certain industries, with special reference to the work of technical colleges and the needs of smaller firms. *Research Grants*: Dr. R. Common (lecturer in the Department of Geography, University of Glasgow), the geomorphology of the lower Vardar and Aliakmon valleys, Greece; Dr. Florence N. David (reader in statistics, University College, London), the history of probability and statistics; L. W. Derry (head of the Department of Metallurgy, Battersea Polytechnic, London) and E. W. Wilkins (Royal Aeronautical Society), a statistical investigation into the fatigue properties of certain non-ferrous metals; P. M. Fraser (Fellow of All Souls College, Oxford), a corpus of Ptolemaic inscriptions; Dr. O. R. Gurney (Shillito reader in Assyriology, University of Oxford), the Assyrian literary tablets from Sultantepe now in Ankara; Dr. V. H. Heywood (systematic botanist), a botanical investigation of the mountainous zones of south-east Spain; P. A. D. Hollom (accountant), distribution of field characters of birds of the eastern Mediterranean region; S. H. F. Lloyd (director, British Institute of Archaeology, Ankara), Beycesultan excavations—a supposed centre of late Bronze Age civilization in non-Hittite Anatolia; Dr. A. G. Lowndes (schoolmaster, Plymouth College), tracer minerals and deep-water drift in the western approaches to the English Channel; Dr. A. Lamont (geologist and journalist), faunas of cherts in the southern uplands of Scotland; Miss R. L. B. Moss (editor, *Topographical Bibliography*), ancient Egyptian inscribed and sculptured objects in Russian museums; Dr. F. J. North (keeper, Department of Geology, National Museum of Wales, Cardiff), a biography of Sir H. T. de la Beche, founder of the Geological Museum; Dr. H. Scott (formerly assistant keeper, Department of Entomology, British Museum (Natural History)), biogeographical research at high altitudes in south and south-eastern Ethiopia; Dr. Marjorie M. Sweeting (tutor in geography, St. Hugh's College, Oxford), physiographical investigations in the 'Cookpit Country' of Jamaica; A. Young (lecturer in the Department of Applied Mathematics, University of Liverpool), analysis of observations of the variation of latitude.

Commonwealth Fund Fellowships

THE Committee of Award of the Commonwealth Fund Fellowships announces the following elections, among others, for 1955–56: *General Fellowships*: M. F. Atiyah, Trinity College, Cambridge (mathematics); A. O. Betts, Royal Veterinary College, London, and Cambridge (veterinary science); D. J. Candlin, Trinity College, Cambridge, and Birmingham (physics); M. A. E. Dummett, All Souls College, Oxford (philosophy); H. M. Frey, Balliol College, Oxford (chemistry); K. W. Gruenberg, Magdalene College, Cambridge, and Queen Mary College, London (mathematics); C. W. McCombie, Aberdeen (physics); A. R. Muir, Edinburgh (medicine); J. C. Polkinghorne, Trinity College, Cambridge (physics); A. P. Ryle, Trinity College, Cambridge (biochemistry); K. E. Snellson, Trinity College, Cambridge (engineering); J. H. Williamson, Edinburgh, Christ's College, Cambridge, and Queen's University, Belfast (mathematics); D. G. Wilson, Birmingham and Nottingham

(chemical engineering); P. D. Wood, Aberystwyth and Reading (geography); *Home Civil Service Fellowships*: W. J. Bray (Post Office Engineering Department); F. Caunce (Ministry of Education); A. W. Peterson (Home Office); H. P. Rowe (Treasury); J. Seddon (Ministry of Supply); *Colonial Civil Service Fellowships*: M. F. H. Abraham (Kenya); J. H. Alman (North Borneo).

University of Birmingham

PROF. T. U. MATTHEW, Lucas professor of engineering production in the University of Birmingham, is resigning from his chair on appointment to a post with Tube Investments, Ltd. The following have been appointed lecturers in the University: H. Gilmour (petroleum production engineering) and Dr. A. Sagarra (chemical engineering). The title of University Research Fellow has been given to the following during the tenure of their present posts. *Physics*: Dr. J. C. Bower (senior lecturer in physics, University of Melbourne); Prof. G. Martelli (Pisa); Dr. K. K. Damodaran, Dr. S. J. Goldsack and Dr. M. M. Winn (Department of Scientific and Industrial Research). *Chemistry*: Dr. J. R. Urwin (lecturer in chemistry, University of Adelaide); Dr. H. Weigel (Aachen). *Experimental Pathology*: Dr. D. R. Stanworth and Dr. S. T. C. Wright.

National Research Council, Canada: Members

THE following have been appointed new members of the National Research Council, Canada, for three years from April 1: Dr. R. S. Jane, executive vice-president, Shawinigan Chemicals, Ltd., Montreal; and Dr. H. G. Thode, principal of Hamilton College and director of research at McMaster University, Hamilton, Ontario. Three other members of the Council have been reappointed for a further term of three years: Dr. C. J. Mackenzie, president of the Atomic Energy Control Board, Ottawa; Dr. T. Thorvaldson, emeritus dean of graduate studies, University of Saskatchewan, Saskatoon; and Dr. W. H. Watson, professor and head of the Department of Physics, University of Toronto.

Royal Society of South Africa: Council

THE Council for 1955 of the Royal Society of South Africa has been elected as follows: *President*, S. H. Haughton; *Honorary General Secretary*, W. J. Talbot; *Honorary Treasurer*, N. Sapeika; *Acting Honorary Editor of Transactions*, A. M. Talbot; *Honorary Librarian*, E. Newbery; *Other Members of Council*, H. B. S. Cooke, W. J. Copenhagen, J. H. Day, R. Elsdon-Dew, C. van Riet Lowe, S. M. Naudé, S. H. Skaife and J. L. B. Smith.

American Academy of Arts and Sciences

THE following have been elected officers for the year 1955–56 of the American Academy of Arts and Sciences: *President*, J. E. Burchard; *Vice-President of Class I* (Mathematical and Physical Sciences), E. L. Bowles; *Vice-President of Class II* (Biological Sciences), H. Hoagland; *Vice-President of Class III* (Social Arts and Sciences), D. F. Edwards; *Vice-President of Class IV* (Humanities), R. Ulich; *Secretary*, W. C. Greene; *Treasurer*, T. B. Adams; *Editor and Librarian*, W. M. Whitehill. The following have been elected, among others, foreign honorary members of the Academy: Class I, Prof. A. C. B. Lovell, professor of radio astronomy in the University of Manchester; Class II, Dr. J. A. M. Runnström, of the Wenner-Grens Institute for Experimental Biology, Stockholm.

Linnean Society of London

THE following have been elected officers of the Linnean Society of London for the session 1955-56: *President*, Dr. H. Hamshaw Thomas; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. George Taylor (botany) and Mr. H. R. Hewer (zoology); *New Members of Council*, Mr. P. R. Bell, Dr. Margaret E. Brown, Dr. A. J. Cain, Mr. C. C. Hentschel and Dr. H. Hamshaw Thomas. The following were appointed vice-presidents for the session 1955-56: Dr. A. Tindell Hopwood, Lieut.-Colonel R. B. Seymour Sewell, Colonel F. C. Stern and Mr. E. J. H. Corner. Dr. B. O. Dodge (New York), Prof. E. Melin (Uppsala) and Prof. W. R. Taylor (Michigan) were elected foreign members of the Society, and Mr. Gerald Atkinson was elected an associate *honoris causa*.

Physical Chemistry of Enzymes: Faraday Society Discussion in Oxford

THE Faraday Society will be holding a general discussion on "The Physical Chemistry of Enzymes" in the University Laboratory of Physiology, Parks Road, Oxford, during August 10-12, under the chairmanship of the president of the Society, Prof. R. G. W. Norrish. A general introduction to the subject will be given by Dr. M. Dixon (Cambridge). The discussion will be in two parts, dealing respectively with characterization and physical properties and with kinetics and mechanisms, and twenty-nine papers will be read, advance proofs of which will be ready early in July. College accommodation is available in Oxford and must be booked by August 2. All inquiries should be directed to the Secretary of the Society at 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

The Botanical Research Fund

THE Botanical Research Fund is a small private trust fund founded in July 1913. The first Trustees to be appointed were Dr. E. M. Berridge, Mr. A. D. Cotton and Miss Gulielma Lister. The purpose of the Fund is to encourage research in botany in all its branches and to assist research workers, more especially women, and particularly those with some previous experience of research and who, for some reason, may not be eligible for grants from public or university funds. The method is to make short-term grants in aid of maintenance, research expenses or assistance. The grants may be renewed in special circumstances; but assistance over lengthy periods is not contemplated. Further information can be obtained from the hon. secretary, Dr. E. M. Delf, 243 Haverstock Hill, N.W.3.

Announcements

UNDER the terms of the scheme to commemorate the late Lord Rutherford of Nelson, the Council of the Royal Society has appointed Mr. N. W. Tanner, a graduate of the University of Melbourne, as a Rutherford Scholar for three years from October 1, to carry out research in nuclear physics in the Cavendish Laboratory, Cambridge.

THE following appointments have been made in the University of Sheffield: Dr. A. L. Cullen, to the chair of electrical engineering; Dr. G. B. Greenough, to be senior lecturer in physical metallurgy; and J. O. Isard, to be lecturer in the Department of Glass Technology.

THE Italian Society of Geophysics and Meteorology is offering two prizes of 100,000 lire each (about £60

for an original work on the physics of the solid earth or hydrosphere and on the physics of the atmosphere, respectively. The prizes are open to persons of any nationality, and joint contributions are permissible. The work, written in Italian, must be sent before February 29, 1956, to the Società Italiana di Geofisica e Meteorologica, via Balbi 5, Genova.

FOR the first time, the Fisheries Research Board of Canada has awarded scholarships similar to those of the National Research Council of Canada. One fellowship worth 1,400 dollars, seven studentships worth 1,100 dollars each, and four bursaries worth 800 dollars each have been awarded for the year 1955-56. The funds for these awards have been made available by the Fisheries Research Board, and the selection of candidates was made by the Board with the help of the National Research Council.

THE General Electric Co., Ltd., has decided to award annually two scholarships to employees in its home establishments or associated companies so that they can take a degree, do research or generally pursue a course of higher learning in a technical or scientific subject (including management or commerce). In general, there will be no restrictions on a candidate's age or choice of subject. Scholars will undertake to remain with the Company for three years after the completion of their course, and will spend an agreed period in one of the Company's establishments during vacations. They will continue to receive their normal emoluments, and the Company will pay for their maintenance and fees at the university or other establishment where the scholarship is held.

THE annual meeting of the Society of Chemical Industry will be held in Birmingham during July 11-16. Included in the programme will be the presentation, on July 13, of the Society's Medal to Sir Eric Rideal, followed by his address on "Colloid Science"; and on July 14 the Chance Memorial Lecture, given by Mr. H. V. Potter, of Bakelite, Ltd., who will speak on "Welfare in Industry". A historical exhibition illustrating the rise of the chemical industry in the area during the past two hundred years will be shown in the University of Birmingham throughout the meeting. Further information can be obtained from the honorary secretary of the Birmingham and Midland Section of the Society, J. H. Bennett, c/o Bakelite, Ltd., Redfern Road, Tyseley, Birmingham 11.

A CONFERENCE on the "Use of Isotopes in Agriculture" will be held during January 12-14 at Michigan State University, East Lansing, Michigan. It will be sponsored by the council of participating institutions of the Argonne National Laboratory. There will be sessions both for invited and for contributed research papers. Details concerning the submission of papers will be published later. The guest speakers from abroad are to be Dr. S. J. Folley (Shinfield, Reading) and Dr. A. Gustafsson (Stockholm). Co-ordinated with this, the American Association for the Advancement of Science and the Oak Ridge Institute for Nuclear Studies will sponsor a related conference on "Atomic Energy and Agriculture" at Atlanta during the Georgia meetings of the American Association during December 26-30. At East Lansing the papers will deal especially with laboratory problems, experimental approaches and results. The Atlanta sessions will be concerned with the present status and future outlook for applications of atomic energy in agriculture.

AERO RESEARCH, LTD.: TWENTY-FIRST ANNIVERSARY

THE firm of Aero Research, Ltd., at Duxford, Cambridge, owes its inception in 1934 to the urge of a university man—Dr. N. A. de Bruyne, at that time a Fellow of Trinity College, Cambridge—to carry out his own applied research work. This type of firm is probably commoner abroad than in Britain, although the Cambridge Instrument Co., Ltd., may be cited as another example.

During the first few years of its life as a small research unit, it pioneered a number of developments that have since proved their worth. These include structural materials for aircraft, honeycomb structures (British Patent 577,790 of 1938), the analysis of sandwich stabilization (*J. Roy. Aero. Soc.*, 44, 1; 1940) and the conception and realization in 1941 of the technique of metal-to-metal glueing for aircraft structures. This work on metal-to-metal adhesives called for both an investigation of the problems of adhesion (see, for example, *Aircraft Engineering*, 16, 115, 140; 1944. *J. Sci. Instr.*, 24, 29; 1947. *Research*, 6, 362; 1953) as well as the production problems presented by its almost immediate application in the de Havilland Hornet fighter. The techniques developed at that time remain the basis of the widespread use of 'Redux' glue in modern civil aircraft. The report on the Comet aircraft accidents unequivocally exonerated this method of construction and, in view of the conclusions reached by the inquiry, its use is to be welcomed as a method of reducing stress concentrations (Duncan, W. J., *Engineering*, -179, 196; 1950).

In all its projects the company has consistently emphasized the need for the research man to follow through to the final application of his work, as

evidenced even in 1934 by the building of a complete aeroplane to demonstrate the value of concepts, such as Wagner's tension field analysis, that were new at that time (*R. and M.* 1694).

On the outbreak of the Second World War the company made for the Ministry of Aircraft Production thirty Miles Magister tail-planes, and a Spitfire fuselage of plastic material; their performance on test (including flight trials of a tail-plane) was entirely satisfactory, but as the shortage of light alloys was overcome, the need for substitutes disappeared. With the rise in aircraft speeds that has since taken place, however, interest in plastics for aircraft has considerably revived. A war-time development that considerably accelerated the production of wooden aircraft and gliders was the 'strip heating' process for which the Royal Commission on Awards to Inventors made an *ex gratia* award.

Until 1946 the company had been wholly owned by Dr. N. A. de Bruyne, but in that year a majority shareholding was taken up by Ciba, Ltd., the world-wide organization known for its research in dyestuffs, pharmaceuticals and plastics. Under an arrangement with Ciba, Ltd., Aero Research, Ltd., continued under its own board as an active research centre, as well as becoming a large production unit for 'Araldite' epoxy resins and the 'Aerolite' urea-formaldehyde adhesives which the company had been making since 1937.

The recent visit of H.R.H. the Duke of Edinburgh on April 20 provided a fitting occasion to celebrate the twenty-first birthday of the company by a display of research and production, including some of the new high-temperature adhesives which are now under development.

FATIGUE IN METALS

AT a joint meeting in the Clarendon Laboratory, Oxford, on April 15, of the Oxford Local Section and the Metal Physics Committee of the Institute of Metals, the morning session was devoted to a discussion on "Fatigue". Prof. G. V. Raynor (Birmingham) presided, and invited papers were given by Dr. N. Thompson (Bristol) and Dr. J. Holden (National Physical Laboratory, Teddington). Dr. Thompson first mentioned the usual analysis of a fatigue experiment into three stages, consisting respectively of a period of rapid work-hardening, a long secondary stage in which local deformation may increase slowly but nothing much seems to happen, and a short third stage in which a crack is rapidly propagated, leading to failure. In contrast to this, recent work suggests that the formation and growth of the crack occupy a considerable part of the second stage, and Dr. Thompson devoted most of his introductory talk to a discussion of the evidence for what he described as this still slightly heterodox view.

In specimens containing notches, it is generally accepted that a crack may be present from an early stage in the fatigue life. The difficulty here is to explain why this crack does not spread rapidly, and no very convincing reason has yet been given. In plane specimens, without deliberately introduced

stress raisers, cracks are not normally visible until just before failure. A theoretical model, due to Head suggests that the length l of a crack is given by a formula of the type

$$l^{1/2} = 1/A(N_{\infty} - N)$$

where N is the number of cycles, and N_{∞} the number of cycles to failure. The rate of growth of the crack is thus proportional to $l^{3/2}$, and since this varies so rapidly, it is possible that for a large part of its life the crack may be too small to be visible. The few experimental measurements which have been made are in agreement with Head's equation.

Dr. Thompson next mentioned some experiments by Sinclair and Dolan, in which fatigue tests on α -brass were interrupted every 20 per cent of the estimated life in order to give the specimen a half hour annealing treatment at 400° C. These anneals had no effect on the fatigue life, although the specimen was completely resoftened at every stage. Sinclair and Dolan suggested that the only type of defect which would survive the annealing treatment was a small crack, which must thus have been formed in the first 20 per cent of the life. Similar experiment at Bristol in which copper specimens were annealed

at 600° C. every 10 per cent of the estimated life produced the same result.

In recent work at Bristol, specimens of high-purity copper were given a careful surface preparation and finally electropolished before testing in push-pull at 1,000 c./s. The specimens were removed and examined at various stages in the experiment. It was found that the eventual fatigue crack always originated from an intense slip band formed in the early part of the deformation; the path of the crack in both directions from this point was shown by a very high density of slip markings, while the central portion was relatively free from slip. To reduce difficulties caused by the complex nature of the surface markings, the specimens were re-electropolished at various stages during the experiments, a standard technique allowing the removal of $\sim 2\mu$ of material. This polish was found to remove nearly all the slip markings, but a few remained and are called 'persistent' slip bands. Persistent slip bands appeared after about 4 per cent of the fatigue life, and increased in number during the experiment; after about 40 per cent of the life, some of them had definitely spread into neighbouring grains, and after 70–80 per cent of the life they were recognizable as small cracks. Application of a large tensile stress to a specimen containing a number of persistent markings resulted in the opening out into visible cracks of all the markings which extended over more than one grain diameter. These markings thus represent micro-cracks, and the evidence strongly suggests that cracks form at a very early stage in the fatigue process. Dr. Thompson ended by pointing out there is some uncertainty in the description of a very small crack in the early stages of the process; the question of whether or not the persistent markings are micro-cracks when they are less than one grain diameter in length may be partially a matter of definition.

Dr. Holden's paper was concerned with the now popular view that recovery processes occur during the course of fatigue, even at room temperature. Specimens which are normally metallurgically stable thus become unstable during fatigue conditions, and diffusion and related phenomena may be greatly increased. The effect on precipitation was illustrated by recent experiments at the National Physical Laboratory on iron, copper and commercial aluminium, in which a progressive loading technique was used. The behaviour of the iron and aluminium specimens was essentially similar, and indicated that greatly enhanced ageing occurred, especially in the aluminium.

A more direct indication that diffusion is facilitated during fatigue is provided by experiments on the internal oxidation of copper alloys containing 0.01 per cent silicon. The process of internal oxidation depends on the inward diffusion of oxygen atoms through a surface sub-scale layer, and the diffusion of silicon atoms within the alloy. Under static conditions, it is known that periods of about one month are required to produce a detectable sub-scale at 300° C. Fatigue tests at this temperature resulted in oxide precipitation within the gauge length after 200–300 hr., although there was no sign of precipitation within the unstressed parts of the specimens.

Having demonstrated the existence of enhanced diffusion effects, Dr. Holden finally outlined experiments now being undertaken with the object of determining the type of lattice defect which is responsible. Low-angle X-ray diffraction studies are being made on 50- μ copper foil specimens given

pulsating tension fatigue tests. After testing for less than 5 per cent of the fatigue life, very pronounced low-angle streaks are found, and these appear to be generally similar to the streaks observed in the very early stages of ageing. The streaks vary from grain to grain, and are unaffected by annealing the foil for an hour at 150° C.

In the general discussion, some attention was paid to the nature of the persistent slip markings. Dr. Thompson emphasized that they are retained after annealing, and are not simply large steps, since the standard electropolishing treatment has been found to remove the slip bands formed by static tensile deformation. Mr. H. Mallon (Shrivenham) said that persistent slip markings were formed when α -brass was deformed more than 20 per cent, but closer examination showed them to be composed of very small etch pits. Mr. G. Smith (Cambridge) described work on fatigue tests at stresses below the fatigue limit. Etch-pits were found to remain in regions where large slip bands had been visible before polishing; on testing at higher stresses, these linked up together to form markings.

In reply to a question, Dr. Thompson said that the cracks in his specimens always originated from the free surface, even though push-pull testing was used. He described further experiments in which 20–30% of surface material was removed, and the persistent slip markings then disappeared. The markings on one specimen were removed in this way after ~ 25 per cent of the estimated life, and testing at the same stress was then resumed. This procedure was repeated seven times in all, so that the specimen had lasted for 225 per cent of its normal life, and there seemed no reason to doubt that the process could be continued until there was no specimen left.

Dr. R. T. Parker (Banbury) pointed out that Dr. Thompson's results implied that the grain size should be an important factor in fatigue; there was general agreement on this, but critical data seem to be lacking. Dr. A. N. Turner (Banbury) raised the question of fatigue in non-metallic materials, and also asked about experiments on single crystals. Dr. Thompson said that experiments on single crystals at Bristol had given essentially similar results to those on polycrystalline material; the crack again originated in an intense slip band. Dr. E. G. Stanford (Banbury) mentioned Hanstock's work on fatigue, in which internal friction measurements were used. The results did not seem to agree with Dr. Thompson's work. Dr. Thompson pointed out that these experiments involved non-uniform stresses, and were made on precipitation-hardening alloys, which are metallurgically unstable under fatigue conditions. Experiments at Bristol have shown that the internal friction is associated with the total number of visible slip bands; it is markedly affected by annealing, but not by the surface dissolution. There is thus no direct correlation between internal friction and fatigue.

In reply to a question, Dr. Holden amplified his remarks on the low angle X-ray experiments. By analysing the distribution of X-ray intensity, it is hoped to distinguish between effects caused by arrays of dislocations and those due to excess concentrations of lattice vacancies. The session concluded with a description by Dr. E. M. Rosdberg, (Oxford) of recent work on fatigue at the Clarendon Laboratory. *S-N* curves for brass and copper have been determined at room temperature, 90° K. and 20° K. At a given stress level, the fatigue lives were in the approximate

ratios 1:10:100. More significantly, the stress required for failure after a given number of cycles increased in the same ratios ($\sim 1:1.5:2$) as the static ultimate tensile strength. Work at liquid helium temperature, now proceeding, shows still further increase in fatigue life, although the correlation with the change in ultimate tensile strength is no longer valid. No one seemed to have a ready explanation for these rather surprising results.

The afternoon session of the meeting was in the form of a general discussion, in which a panel of members of the Metal Physics Committee attempted to answer questions suggested by the local section. The current interest in fatigue problems was shown by the question, "Why have very high-strength aluminium alloys a fatigue strength no better than that of medium-strength alloys?", which produced, in effect, a continuation of the morning discussion.

J. W. CHRISTIAN

AROMATIC SUBSTITUTION

ON March 29 a symposium was held by the Chemistry Department of Queen Mary College, London, on "Aromatic Substitution", with Prof. E. R. H. Jones in the chair. The six contributions covered various aspects of electrophilic, nucleophilic and homolytic substitution.

Prof. M. J. S. Dewar reviewed the general theory of aromatic substitution in terms of the Wheland transition-state treatment and the molecular orbital method. The latter method may be used to calculate the position of substitution in polycyclic alternant hydrocarbons, and the results obtained are generally in agreement with the experimental results. The theory does not take into account steric hindrance, which appears to occur particularly in α -naphthalenic positions such as the 4-position in phenanthrene. Electrophilic substitution in heterocyclic systems was then discussed and the molecular orbital theory shown to be applicable in this field. Finally, Prof. Dewar described work being carried out on the nitration of quinoline which shows that this reaction proceeds by different mechanisms in acetic anhydride and sulphuric acid solution. In the subsequent discussion Prof. E. D. Hughes emphasized the importance of the reagent and also the effect of temperature on the orientation of the substituent. Prof. Dewar agreed and illustrated the effect of the reactivity of the reagent.

Dr. G. Baddeley¹ discussed the Friedel-Crafts acylation and alkylation of aromatic compounds, and emphasized the effect of the reactivity of the reagent on the nature of the product. With aluminium chloride in methylene chloride solution the usual orientation rules were observed, whereas if the solvent was nitromethane or ether the reagent was less reactive and 'abnormal' products were obtained. This was illustrated with numerous examples such as the substitution of anthracene, which occurs in the 9-position in methylene chloride solution but in the 1- and 2-positions in nitromethane solution. Dr. Baddeley ascribed the abnormal orientation to complex formation between the catalyst and solvent, attack by the bulky complex being liable to steric hindrance. Dr. E. A. Braude suggested that reversibility of the reaction might account for the abnormal orientation in polar solvents, but Dr. Baddeley said that, if excess aluminium chloride is avoided and the

hydrogen chloride removed, the reactions are not reversible.

Dr. P. B. D. de la Mare then read a paper on the chlorination and bromination of aromatic compounds. He stated that these reactions, when carried out by a solution of the halogen in hydroxylic solvents, can be shown kinetically to involve molecular halogen, but that brominations by aqueous hypobromous acid have a kinetic form which implies that the electrophilic reagent carries a full positive charge. Dr. de la Mare then compared molecular halogenation with ionic nitration and showed that the results suggest that, while the positively charged reagent evokes the inductive effect of the substituent most powerfully, the molecular reagent evokes the conjugative electromeric effect more powerfully.

The afternoon session was opened by Dr. N. B. Chapman, who gave a short survey of nucleophilic substitution and then proceeded to discuss the nucleophilic displacement of halogen. He directed attention to possible duality of mechanism (analogy with saturated systems) and to the possibility of complexity of mechanism in bimolecular processes, and outlined the structural requirements for nucleophilic substitution in homocyclic aromatic compounds. Dr. Chapman then discussed the quantum-mechanical background to the nucleophilic displacement of halogen in heterocyclic compounds (mono- and di-aza-naphthalenes) and gave an account of some kinetic investigations which have provided kinetic results for comparison with the approximate quantum-mechanical calculations; the agreement between the calculated and observed activation energies is not very good. In the discussion Dr. E. Parker suggested that the structure of the transition-state might involve *d*-orbitals, and this suggestion was generally accepted as being probable. Prof. Dewar suggested that a comparison of calculated activation energies with observed rates of reaction might be more correct and lead to a better agreement between theory and experiment.

Prof. W. Bradley discussed nucleophilic substitutions in which hydrogen is replaced by an anion, the formation of *o*-nitrophenol from nitrobenzene and potassium hydroxide being a typical example. The reactivity of the nucleus towards nucleophilic substitution decreases from anthracene to naphthalene to benzene, and nucleophilic substitution is facilitated by a carbonyl or nitro group attached to the nucleus, the positions *ortho-para* to the group being preferentially attached. Numerous examples show that, on direct hydroxylation with potassium hydroxide, mono-ketones and di-ketones yield respectively mono- and di-hydroxy compounds, and substitution by other anions follows a similar course. Prof. Bradley then gave several examples where substitution by an anion is accompanied by self-union of two molecules of the aromatic reactant, usually via a carbon atom *para* to a carbonyl group. He expressed the view that this is due to the anion functioning as a base and removing a proton from the aromatic reactant.

Prof. D. H. Hey opened his paper on homolytic substitution² by outlining the reactions by which phenyl radicals may be generated, and he then briefly discussed the partial rate factors for the phenylation of a series of mono-substituted benzene derivatives. He described the phenylation of toluene, ethylbenzene, isopropylbenzene and *tert*-butylbenzene; with the first three of these compounds the reactions are complicated by dimerization due to side-chain attack.

In the case of *tert*-butylbenzene this does not occur, but there is a marked steric opposition to substitution at the *ortho* positions which results in the first example of overall deactivation encountered in homolytic substitution. Prof. Hey then outlined some recent investigations on the proportions of the isomeric phenylpyridines formed in the phenylation of pyridine using a number of different sources of phenyl radicals. The results were independent of the source of the radical, except when the source was phenylazotriphenylmethane. This anomalous result was shown to be due to the formation of a by-product in which it appeared that the triphenylmethyl grouping was incorporated.

In view of the interest aroused by this symposium and by one held last year³ at Queen Mary College, it has been decided to make the symposium an annual event, dealing with some topic of current interest in the field of organic reaction mechanisms.

M. F. ANSELL
M. J. S. DEWAR

¹ Baddeley, G., *Quart. Rev.*, 8, 355 (1954).

² Hey, D. H., *et al.*, *J. Chem. Soc.*, 3352 (1954), and earlier papers.

³ Ansell, M. F., and Dewar, M. J. S., *Nature*, 173, 898 (1954).

SOIL ZOOLOGY

EASTER SCHOOL AT NOTTINGHAM

THE second Easter school in agricultural science in the University of Nottingham School of Agriculture, Sutton Bonington, held during April 1-7, was devoted to soil zoology. This symposium and colloquium were limited to a membership of seventy, which included not only a large number of specialists in soil zoology and pedology, among whom were several distinguished scientific workers from other European countries, but also a number of biologists who wished to acquaint themselves with this field. The function of the meeting, therefore, was to provide a tilting-ground for discussion of papers delivered by specialists and, in addition, tuition by lecture, demonstration and practical class-work for those less familiar with the ramifications of this rapidly growing subject.

After the address of welcome by Prof. E. G. Hallsworth, the opening paper, on soil animals, by Prof. W. Kühnelt (Vienna), and the subsequent paper by Dr. P. W. Murphy (Rothamsted) on the ecology of the fauna of the forest soils, served as introductions to soil zoology and enabled the later more specialized contributions to be viewed in their ecological perspective. The difficulty of extracting animals from the soil in a condition which permits identification and in quantities which reflect the sizes of field populations has long been recognized. The paper by Mr. A. Macfadyen (Oxford), on a comparison of sampling methods for soil arthropods, was therefore welcomed by the entomologists present. An informal address on flotation methods of extraction was also given by Dr. F. S. J. Hollick (Cambridge). Dr. F. Raw's paper on a flotation extraction process for soil micro-arthropods was demonstrated in his absence by his colleagues, Mr. J. M. Dobson and Mr. J. W. Stephenson (Rothamsted). As a direct result of careful extraction methods, information on the distribution of animals in the soil is increasing. This was well shown by the studies of Mr. D. H. Murphy (Durham) on long-term changes in Collembola

populations, with special reference to the fauna of moorland soils; by Mr. N. Haarløv (Copenhagen) in his contribution on vertical distribution of mites and Collembola in relation to soil structure; and by Dr. C. Overgaard Nielsen (Fæmøller, Denmark) in his survey of a year's results obtained by a recent method for the extraction of soil-inhabiting enchytraeid worms. The roles and distribution of earthworms were dealt with in two papers: Dr. W. J. Guild (Edinburgh) on earthworms and soil structure, and Dr. J. E. Satchell (Nature Conservancy, Grange-over-Sands) on some aspects of earthworm ecology.

Although most of the practical difficulties in the identification of soil animals were adequately explained in the practical classes, Dr. G. O. Evans (British Museum) gave a most useful talk on the problems encountered in naming terrestrial mites. The general biology of some of the less-worked groups was covered by Ir. B. G. Peters (Rothamsted), speaking on soil-inhabiting nematodes; by Mr. J. G. Blower (Manchester), on myriapods as soil animals; and by Mr. W. V. Harris (Commonwealth Institute, London—in *absentia*), on termites and the soil, this last lecture being introduced by Mr. W. A. Sands (Commonwealth Institute). A group with which the average zoologist is even less familiar, that of the predaceous fungi, was very ably dealt with by Dr. C. L. Duddington (London) and Dr. Mary Peach (London).

The relations of soil type and agricultural practice to the fauna of agricultural land were outlined in two lectures by Prof. W. Tischler (Kiel). The penultimate session was almost entirely devoted to the more practical aspects of soil ecology. A brief review was given by Mr. E. B. Brown (National Agricultural Advisory Service, Cambridge) in his paper on some current British soil pest problems. Mr. F. G. W. Jones (Cambridge) gave particular attention to one class of pests in his paper on quantitative methods for the estimation of cyst-forming eelworms in the soil. Some of the interesting aspects of the application of insecticides to soils were discussed by Mr. J. G. Sheals (Glasgow) in the effects of DDT and BHC on soil Collembola and Acarina.

On the last morning Prof. W. L. Kubišna (Madrid) showed a series of coloured slides illustrating the micro-structure of soil, paying special attention to the humus type. This was a fitting end to the meeting, as the cardinal importance of animal activity in the determination of humus type was demonstrated. Moreover, Prof. Kubišna's remarks helped pedologists and zoologists alike to a more rigorous appreciation of the terms 'mull', 'mor' and 'moder', terms often used and as often misused during the meeting. On the last morning also, a number of valuable contributions which it had unfortunately been found impossible to incorporate in the formal proceedings were read 'by title', their texts having been circulated during the course and opportunity given for their discussion.

Several hours each day were devoted to practical demonstrations of various techniques, with adequate opportunities for testing them individually. All the demonstrations attracted considerable attention, and though it is perhaps invidious to single out any particular one, special interest was shown in the soil-sectioning technique developed by Mr. N. Haarløv and Dr. T. Weis-Fogh.

In general, this meeting at Sutton Bonington was a great success, and much of the credit is due to the exceptional facilities provided at the School of

Agriculture and to the preparatory work and organization done by Mr. D. K. McE. Kevan and his small staff. The entire proceedings of the Easter school, including the techniques demonstrated and the discussions of papers, will be published shortly (by Butterworth's Scientific Publications), edited by Mr. Kevan.

O. GILBERT
J. HOBART

A CONDITIONING LABORATORY FOR THE INVESTIGATION OF PERSONALITY AND CORTICAL FUNCTIONING

By DR. C. M. FRANKS

Psychology Department, University of London, Institute
of Psychiatry, Maudsley Hospital, London, S.E.5

A SOUND-PROOF conditioning laboratory has been established at the University of London Institute of Psychiatry (at the Maudsley Hospital, London, S.E.5) in the Department of Psychology. At present the laboratory is equipped for eye-blink conditioning (the unconditioned stimulus being an air puff and the conditioned stimulus a tone), psychogalvanic reflex (P.G.R.) conditioning and cardiac conditioning. The subject is seated at a small booth with his head resting against a padded head-rest and his feet on a foot-rest, so that his field of vision is largely confined to the walls of this booth. All stimuli are rigidly standardized, being delivered and recorded electromechanically; the relative durations and times of onset of the stimuli are controlled by electronic timers. Thus the total experimental conditions are accurately standardized and capable of precise duplication by workers in other laboratories.

A novel feature of the conditioning apparatus is the method of recording the eye-blink movements. Hitherto, various mechanical or electromechanical methods have been used, both in Great Britain and elsewhere. Almost all these methods involve attaching an artificial eyelash to the eyelid or placing electrodes on or near the eyelid. Such methods are inconvenient for the subject and especially unsuitable for psychiatric patients. The present method requires no direct contact with the eye or eyelid. It is based on photoelectric principles and is to be described in detail elsewhere. A small photoelectric cell, sensitive in the visible region of the spectrum, is mounted on one lens of a pair of plain-glass spectacles. As the eyelid blinks, so the amount of light reflected on the cell cathode changes. The varying e.m.f. generated in the photo-cell is then fed into a linear amplifier and used to drive the recording pen of a recording milliammeter.

The major experiment carried out at the laboratory has been a follow-up and elaboration of an observation originally made by Pavlov. Before discussing this observation, it is first necessary to review briefly the main tenets of Pavlov's theory of cortical functioning. Pavlov's theory¹ emphasizes two basic processes, namely, 'excitation' and 'inhibition'. The excitatory process is said to be produced during the formation of a positive conditioned reflex. As evidence for a state of excitation being present in the cortex, Pavlov cites the fact that a stimulus which was not originally

used as a conditioned stimulus may be able in certain instances to elicit the conditioned response. This is supposed to be because the excitatory process, originating largely in the sensory areas of the cortex which received the impulses from the conditioned stimulus source, irradiates the adjacent areas. A similar argument, based on experimental findings, is used by Pavlov to explain the formation and irradiation of the inhibitory process. It is necessary to stress here that the inhibitory process, as conceived by Pavlov, is a positive process and not merely the absence of excitation. As to the physiological nature of this process, Pavlov admits his ignorance. The term 'inhibition' is perhaps an unfortunate one, since it is used by contemporary psychologists and physiologists in at least three different senses. There is the psychiatric usage of the word, as generally applied to the withdrawn, introverted individual; there is the neurological usage of the word; and there is the present Pavlovian usage.

Pavlov experimented solely with animals. He noticed that a certain kind of dog (which he called the excitatory kind) appeared to be more excitable than other dogs; such dogs developed stable positive conditioned reflexes with ease and retained them readily. Another kind of dog (which he called the inhibitory kind) was, on the other hand, timid, cowed and cautious. These dogs developed positive conditioned responses poorly and they were easily disrupted. After further consideration and experiment with these two kinds of animals, Pavlov concluded that the excitatory type of dog which formed conditioned reflexes readily possessed a predominance of cortical excitation, and that the inhibitory type of dog which formed conditioned reflexes poorly possessed a predominance of cortical inhibition. In his later years Pavlov² studied—but never investigated experimentally—psychiatric patients. In particular, he made an observation concerning two kinds of neurotics, the neurasthenic and the hysteric. He concluded that the neurasthenic possessed an exaggeration of the excitatory process and the hysteric an exaggeration of the inhibitory process. Unfortunately, he never followed this observation up, and it has been largely neglected by psychologists and psychiatrists ever since.

It is possible, however, to predict that the neurasthenic patient should condition readily and that the hysteric should condition poorly. The concept of neurasthenia, as used by Pavlov, would seem to be included in the present-day concept of 'dysthymia', as developed by Eysenck³, which comprises the 'anxiety states, the obsessive compulsives and the reactive depressions. As well as being neurotic, all dysthymics have in common a marked predisposition towards introversion. Similarly the hysterics—and psychopaths—as well as being neurotic have a marked tendency towards extraversion. Implicit in this classification is the mutual orthogonality of the two dimensions of neuroticism and introversion-extraversion. Using eyelid and psychogalvanic reflex conditioning, it has been experimentally demonstrated in this laboratory that, as demanded by the theory, the dysthymic patients condition readily and the hysteric and psychopathic patients condition poorly.

Spence⁴ and his co-workers have demonstrated that anxious subjects are superior to non-anxious in the development of conditioned eye-blink responses. Similar results were obtained by Welch and Kubis⁵, using psychogalvanic reflex conditioning. This may

be because they are more neurotic than non-anxious subjects, or it may be because they are more introverted. If the former were true, then all neurotic subjects would condition better than normal ones; if the latter were true, then dysthymic neurotics would condition readily and hysteric and psychopathic neurotics would condition poorly. Thus the present experiment is a crucial one. It would seem that conditionability is related to introversion-extraversion (which in its turn is related to cortical excitation-inhibition) and not to neuroticism. Support for this conclusion is given by the fact that introverted normal subjects condition better than extraverted normal subjects. If conditioning is related to cortical excitation, then drugs such as caffeine should increase conditionability, and drugs such as sodium amytal should decrease conditionability. The tentative conclusions from a small pilot study carried out in this laboratory upon sixteen subjects, using intravenous sodium amytal, would suggest that, as predicted, one effect of this drug is to reduce the conditionability of the subjects.

In this preliminary study of sodium amytal and conditioning, the effects of practice and of varying the size of the amytal dose were also considered. An additional variable incorporated into the experimental design was the effect of using a placebo injection. All these variables were related to changes in personality as measured by questionnaire scales such as the Maudsley Medical Questionnaire (neuroticism) and Guilford's *STDCR* scales (introversion-extraversion and neuroticism). Another interesting finding is that this drug apparently has an effect upon the retention of, or ability to form, conditioned eye-blink reflexes as manifest in the re-test situation. In a future study it is hoped to confirm and relate this finding to certain aspects of learning by rote carried out under comparable experimental conditions.

Pavlov demonstrated that certain cortical operations in his dogs resulted in an increase in inhibition and a consequent decrease in conditionability. This would suggest that certain types of brain damage in human subjects, or certain brain operations, such as prefrontal leucotomy, would also result in a decrease in ease of conditionability.

Perhaps it is of interest to mention here that Mrs. A. Petrie, of the Institute of Psychiatry, has carried out an investigation into the effect on personality of a variety of brain operations*. Her published results to date have shown that the personality measurements associated with the dysthymic type change consistently in the direction of extraversion after excisions in the frontal lobe but not after excisions in the cingulate and certain other areas. Included in one of her current projects—carried out in association with Mr. R. A. Willett at this Institute—is an investigation into changes in eye-blink conditionability following on these brain operations.

The programme of the conditioning laboratory includes further experiments with drugs which act as cortical excitants or depressants, and with drugs which increase or decrease sympathetic nervous activity. It is hoped to relate the changes in personality and in conditioned response behaviour caused by these drugs to simultaneous changes in the subjects' electro-encephalograms. It is also hoped to condition reflexes other than those already mentioned. If sufficient reflexes are investigated, covering both central and autonomic nervous systems (each

subject would be conditioned upon each reflex separately), then it should be possible to establish the existence or otherwise of a general factor of conditionability in man.

* Pavlov, I. P., "Conditioned Reflexes" (trans. by G. V. Anrep) (London: Oxf. Univ. Press, 1927).

† Pavlov, I. P., "Lectures on Conditioned Reflexes", 1, "The Higher Nervous Activity (Behaviour) of Animals" (trans. by W. H. Gantt) (London: Laurence and Wishart, 1927); 2, "Conditioned Reflexes and Psychiatry" (trans. by W. H. Gantt) (New York: International Publishers, 1941).

‡ Eysenck, H. J., "The Scientific Study of Personality" (London: Routledge and Kegan Paul, 1952); "The Structure of Human Personality" (London: Methuen, 1953).

§ Spence, K. W., and Taylor, J., *J. Exp. Psychol.*, 42, 188 (1951). Spence, K. W., and Fisher, L. E., *J. Exp. Psychol.*, 45, 116 (1953).

|| Welch, L., and Kubie, J., *J. Psychol.*, 23, 83 (1947); *J. Nerv. Ment. Dis.*, 195, 372 (1947).

¶ Petrie, A., "Personality and the Frontal Lobes" (London: Routledge and Kegan Paul, 1952).

THE WATER SUPPLY OF LONDON

THE easy way of providing a bacteriologically pure domestic water supply is to own or control a gathering ground in a remote and uninhabited district—say, in central Wales—to prohibit farming on it and the access of the public to it, and after storage, to treat this water by filtration and chlorination before it is distributed. The extension of farming during the Second World War and, since then, the increasing numbers of people who want to walk, cycle or motor in the less-inhabited parts of Great Britain have made it difficult to adhere to this policy in its extreme form; the Central Advisory Water Committee of the Ministry of Health recognized this in a report published a few years ago, and recommended that, though the public should not have general access to the banks of storage reservoirs, they should be allowed access to the remainder of a gathering ground*.

Even with this relaxation, however, the water undertaker with a catchment area in a remote district is still in a much more fortunate position than the water authority of London—the Metropolitan Water Board—which supplies about one-sixth of the population of Britain. Its raw water is drawn mainly from the Thames and the Lee—rivers, alkaline in reaction, flowing through lowland farming country, and polluted by sewage effluents and industrial discharges—bacteriologically unsafe, therefore, at the source, and an excellent medium for the growth of algae. From this raw material the Board produces a treated water acknowledged to be of the highest quality. How this is done is explained in the informative and detailed reports of the Board's Director of Water Examination, of which the thirty-fifth has recently been issued†.

Partly, of course, it is done by providing first-class treatment plant and by carrying on continuous research to improve the design and operation of it. But, in addition, the Director of Water Examination has on his staff teams of bacteriologists, biologists and chemists who keep an almost continuous watch on the quality of the water, from the river to the consumer's tap. The amount of work involved in this is prodigious; during 1952, for example, more than forty-five thousand samples of water were examined bacteriologically.

* Central Advisory Water Committee: Report of Gathering Grounds Sub-Committee. (London: H.M.S.O., 1948.)

† Metropolitan Water Board: Report on the Results of the Bacteriological, Chemical and Biological Examination of the London Waters for the Years 1947-1952. (Thirty-fifth Report.) Pp. 116+2 plates. (London: Staples Press, Ltd., 1955) 15s. 6d.

A similar effort is needed to prevent trouble from the growth of algae which, when present in large numbers, may greatly reduce the rate at which water can be passed through sand filters, and may also give rise to very objectionable tastes. Frequent counts of algae are therefore made—in the Lee Valley reservoirs, for example, twice weekly—and from these observations and from the results of chemical determinations (particularly of silicate) it is now usually possible to judge when to take action which will prevent a major nuisance from occurring. Intermittent chlorination, addition of copper sulphate, and the drawing off of water from a particular depth in a reservoir are some of the means used to combat algal troubles. To be effective, however, action must be taken at precisely the right time, and the report makes it clear how very close a watch has to be kept on reservoirs and rivers for this to be possible.

In judging the bacteriological safety of a water supply, many factors are taken into account, but the chief criterion is the number of *Bacterium coli* type I present in unit volume. It is natural, therefore, that much research should have been carried out in the laboratories of the Metropolitan Water Board to improve the methods of determining the numbers of this organism in a sample; the present report includes accounts of comparative tests with media containing peptone from different sources, of tests with a chemically defined medium incorporating glutamic acid, and of a rapid test using Brilliant Green bile broth. This 'rapid' test, however, still occupies two days; it is evident that the development of really rapid methods of enumerating bacteria would be of immense service in the control of a water undertaking.

This report is the last to be presented by Lieut.-Colonel E. F. W. Mackenzie, who became Director of Water Examination in 1939 and who retired recently. His term of office thus included the period of the War when the intricate system of sewers, water mains and treatment plants on which the health of London depends was under concentrated bombardment. It was then, of course, that the meticulous system of testing and control, for which London's water authority has for so long been famous, had its most severe test; in the result, throughout the War no single case of disease which could be attributed to the water supply was ever reported.

AGERATUM HOUSTONIANUM AS A TEST OBJECT FOR GROWTH-SUBSTANCES

H. P. BOTTÉLIER (*Annales Bogorienses*, 1, 3, 185; 1954), using *Ageratum houstonianum* Mill as a test plant in studies of the action of growth-substances, has investigated the relation between the epinastic curvature of the petioles and the concentration of indole acetic acid, and the effect of light thereon. He has observed that the magnitude of the curvature for a given growth-substance concentration depends on the illumination during the reaction and on the age of the leaves, the first adult leaf pair giving the highest values.

The higher the concentration of the growth-substance solution used, the greater the light intensity at which light saturation takes place. Two processes

can be distinguished in which the action of the growth substance leads to an epinastic curving: in one of these light is essential, so that in the dark no curving takes place and the maximum curving appears after illumination for about twenty-four hours; in the other, curving takes place in the dark and is completely inhibited by light after four hours illumination.

In young leaves (second leaf pair) only the first process occurs, while as the leaves become older the second process becomes more and more important. Accordingly, petioles of young leaves do not curve in the dark, but do so strongly in light; as the age increases, the ability to curve in the dark increases and with the sixth leaf pair is equal to that in light. The sensitivity to illumination diminishes fairly rapidly when the petioles are kept in the dark in growth-substance solutions. With short illumination at the beginning of the experiment the curvature is smaller the shorter the illumination. Both phenomena can be explained quantitatively from the rate at which the growth substance is taken up by the petioles, if it is assumed that the growth substance is dealt with directly after it has been taken up, in light according to the first process, in the dark according to the second.

In an investigation of the synergism of indole and indole-3-acetic acid in the rooting of isolated leaves of *Ageratum houstonianum*, M. H. Van Raalte (*ibid.*, 167) has observed that the rooting of petioles of *Ageratum* induced by indole-3-acetic acid was enhanced by the addition of indole. Indole did not increase the effect of naphthalene-1-acetic acid on rooting. The oxidation of indole-3-acetic acid by a crude enzyme extract from etiolated pea seedlings, as determined with the Warburg manometric method, was decreased by the addition of indole. It is suggested that the enhancing effect of indole on the rooting of *Ageratum* induced by indole-3-acetic acid is caused by its decreasing effect on the oxidation of this growth substance in the plant.

RED LECHWE AND CHINESE SIKA

ONCE more the Fauna Preservation Society directs attention to two animals which are in danger of declining to the point of extinction (*Oryx*, 3, No. 1; March 1955). The first is the red lechwe (*Onotragus lechwe lechwe* Gray), the position of which in Northern Rhodesia is described by W. F. H. Ansell. The second is the Chinese sika, varieties of which range from the forests of tropical Formosa to the northern snows of east Siberia; concern for each variety is expressed by Richard Glover.

The lechwe is probably the most typical of Northern Rhodesian antelopes and, according to the Director of Game and Tsetse Control for this territory, numbers have declined alarmingly in recent years. Human agents are mostly responsible for this decline, Europeans blaming Africans and Africans Europeans. Legal enactments now make it difficult for Europeans to kill red lechwes on any great scale and the only large-scale killing is the native lechwe drive, or 'chila', a traditional African way of hunting. Originally, the chila did little more than take the surplus crop of game. To-day the hunting of lechwe has become a commercial proposition, and large numbers of immature animals are being slaughtered.

The African, however, has a strong sense of the traditional, and his claim to proprietary rights over the lechwe cannot be ignored. There is a sporting atmosphere about a chila, which seems to be conducted in the same spirit as a fox-hunt or a race-meeting. There is nothing in the chila, as a method of taking game, that could be objected to by any upholder of field sports, and it involves both skill and strenuous physical effort. The African is far more likely to support conservation measures aimed at preserving his sport than he would be to co-operate in preservation for its own sake—an academic consideration quite outside his apparent interest or present understanding. No solution to this problem has yet been found; but at present it is likely to lie in the direction of control rather than in any attempt at abolition.

Chinese sikas are quite unlike the small and stocky Japanese sikas which roam so many British parks. The majority of Chinese sikas stand 3½ ft. high at the shoulder and are comparable to the average Scottish red deer. They differ from the Japanese sikas, where the antlers of the stag are greyish-black to black; in Chinese sikas they are red.

Sika deer are woodland animals and this has given rise to anxiety. Throughout this century there has been wholesale destruction of forests in China; until the Communist regime few new trees were planted.

Another reason for anxiety is that Chinese physicians have long regarded a preparation of deer's antlers as a cure for impotence. High prices are paid for the antlers, and besides the stalking of stags with rifles, the Chinese make free use of set-guns, snares and pitfalls; with these methods neither hind nor calves are spared. Already some varieties are believed to be extinct. To-day the Chinese sika appears to have joined that group of animals—the European bison, Père David's deer, Mongolian wild horse and Hawaiian goose—the survival of which depends upon their careful management in parks and zoos outside their native habitat. In Great Britain there is a fine herd of Formosan sikas which are kept apart in a special paddock at Woburn, as well as smaller herds at Whipsnade and Chessington Zoos.

FISHERIES RESEARCH IN HONG KONG

DESPITE many difficulties and setbacks, organized fisheries research in Hong Kong forges ahead with outstanding vigour and success. Under Dr. G. A. C. Herklots, it got off to an excellent start just before the Second World War but was brought to an abrupt halt by the Japanese occupation. The early post-war period witnessed resolute attempts to revive the project, and these efforts met with some success: but it was not until the formation of a Fisheries Research Unit affiliated with the Department of Zoology, University of Hong Kong, that the project became again soundly established. In 1950 Dr. David Barker was appointed professor of zoology in the University and acting director of the new Unit. Since then, solid and rapid progress has been made. A specially designed research vessel, the *Alister Hardy*, built in a local shipyard, went into service in January 1954, to initiate an ambitious programme of researches in nearby waters (see *Nature*, 172, 1170; 1953).

Preliminary results of much interest and value are already available and have been published in a new journal, the *Hong Kong University Fisheries Journal**. This publication carries on, under its new name, the former *Journal of the Hong Kong Fisheries Research Station*, originally launched by Dr. Herklots in 1940 but which ran to only three issues because of the War. It is intended to publish the new *Journal* annually for the time being; but as the activities of the Unit expand and multiply, publication will no doubt become more frequent. This first number is well printed on good paper and has an attractive format that does credit to all concerned with its production. It contains four papers on various aspects of fisheries biology, one on the sea snakes (Hydrophiidae) occurring near Hong Kong, and one by Prof. Barker giving an interesting and informative history of the development of fisheries research in Hong Kong.

The Fisheries Research Unit now has its own director, Mr. J. A. Tubb, a graduate of the University of Melbourne, and formerly director of fisheries in North Borneo, and it is to be expected that this, the most easterly of a chain of Commonwealth research stations in the Indo-Pacific region, will quickly become a powerful and progressive influence both locally and internationally within the region. It certainly merits the fullest measure of encouragement and support that can be extended to it by all interested in fisheries and general marine biology in those Far-Eastern waters.

G. A. STEVEN

* *Hong Kong University Fisheries Journal*, No. 1 (December 1954). Edited by Prof. David Barker. Pp. iv+65+12 plates. (Hong Kong: University Press, 1954.) n.p.

ANAPHYLATOXIN, HISTAMINE DEPLETION AND SKIN REACTIONS IN THE RAT*

By DR. M. ROCHA E SILVA and
A. M. ROTHSCHILD

Department of Biochemistry and Pharmacodynamics,
Instituto Biológico, São Paulo, Brazil

AS shown before¹, incubation of rat's plasma with polysaccharides (starch, agar, inulin, etc.) generates a most potent histamine-releasing substance (anaphylatoxin), when assayed by perfusion through the guinea pig lung or by addition to a chamber containing a piece of guinea pig ileum (strong contraction followed by desensitization). Experiments performed in order to test the possibility of activating anaphylatoxin *in vivo*, by injecting starch or agar intravenously into rats, led to the result that, instead of being activated, the plasma of these rats became much less active when assayed *in vitro* with the proper amount of agar as activator. Significant drops of the content of anaphylatoxin to 5–30 per cent of the normal levels could be observed in most animals receiving the polysaccharides intravenously.

This 'depletion' of anaphylatoxin appeared to constitute a favourable condition in which to test the possible role taken by anaphylatoxin in the mechanism of production of several skin reactions involving increased capillary permeability, as revealed by the passage of a colloidal dye (Geygy blue or

* Results presented at the annual meeting of the Braz. Soc. for the Advanc. of Science, held in Ribeirão Preto, São Paulo, Brazil, during November 8–13, 1954.

Table 1

Groups	Treatments Doses (mgm./100 gm.)	No. of animals	Anaphylatoxin (plasma)	Histamine, dorsal skin (μ gm./gm.)	Skin reactions (trypan blue tests)			
					Local ana- phylaxis	48/80 (25 μ gm.)	Dextran (20 μ gm.)	Ovomuc. (20 μ gm.)
Normals	None	6	100%	25.2 $\pm$ 6.1	+++	+++	+++	+++
1	Starch (150 mgm.)	6	0 to 5%	28.8 $\pm$ 1.7	$\pm$; 0	+++	+++	+++
	Agar (150 mgm.)	6	0; 5%; 30%		0	+++	+++	+++
	Glycogen (150 mgm.)	2	25%; 50%					
2	Dextran (100 mgm. i.v.)	4	100%	4.9 $\pm$ 3.5	+++	$\pm$	0	0
	Ovomucoid (100 mgm. i.v.)	4	100%			+	0	0
	48/80 (400 μ gm. i.p.)	4	100%	5.4 $\pm$ 3.5	+++	0	0	0
	48/80 (1.2 mgm. i.p.)	4	100%	less than 3.0 μ gm./gm.	+++	0	0	0
	48/80 (2.0 mgm. i.p.)	2		"	+++	0	0	0

Note. For the local anaphylactic reaction, 20 μ gm. of antibody nitrogen was injected intracutaneously and 2 hr. later 2 mgm. of antigen nitrogen (egg white) plus the dye were injected intravenously.

trypan blue) from the circulation to the treated skin areas. Three potent histamine releasers, low-molecular weight dextran², 48/80 (condensation product of *p*-methoxyphenetylmethylamine with formaldehyde)³ and ovomucoid⁴, which are known to 'deplete' the histamine from the skin when given repeatedly to rats, were also assayed in order to see if there is any cross-desensitization towards themselves or towards the local anaphylactic reaction performed upon the rat's skin according to Ovary's technique⁵, consisting in preparing the skin with a few micrograms of antibody nitrogen and two hours later injecting the antigen plus Geygy blue intravenously.

Two groups of rats were treated as follows: (1) with polysaccharides (starch, agar or glycogen) given twice at a 2-hr. interval; after the second injection, the skin test was performed; and (2) with a low-molecular weight dextran (intravenously) or 48/80 (intraperitoneally) or ovomucoid (intravenously), in repeated injections during 36 hr., in order to reduce substantially the skin histamine. The skin tests were carried out when the skin histamine was at its lowest level³.

The capillary permeability test was carried out by injecting intravenously 0.5 ml. of a 0.5 per cent solution of Geygy blue or 1.0 ml. of a 1 per cent solution of trypan blue, immediately followed by the intracutaneous injections of 0.1 ml. in each place, of the solutions of polysaccharide, dextran, etc. After 10–15 min., the animal was exsanguinated, and the intensity of the reaction was observed in the derma of the inverted skin.

The results are condensed in Table 1. In the animals of the first group, anaphylatoxin was considerably decreased, the skin histamine was practically unchanged and blue tests with 48/80, dextran or ovomucoid were as strong as in normal animals. However, in all animals of this group, the local anaphylactic reaction (Ovary's test) was slight or completely abolished. In the animals of the second group, anaphylatoxin was at a normal level, skin histamine went down to 'depletion' levels, and yet the local anaphylactic reaction was as strong as in the control animals, although the skin reactions to the 'depleters' (dextran, 48/80 and ovomucoid) were completely abolished or very slight.

It thus appears quite clear that the mechanism by which the capillary permeability is increased by such agents as histamine releasers (48/80, dextran and ovomucoid) on one hand, and by the local anaphylactic reaction on the other, are different. It is difficult to understand why in a histamine-depleted skin the antigen-antibody reaction is not at all

decreased, since there are indications that anti-histaminics, such as 'Neo-antergan', strongly depress the local anaphylactic reaction⁶. Either we have to postulate different mechanisms for the release of histamine by the components of group 2 substances and by the anaphylactic reaction, or some other substance is released in rat's skin under the action of the antigen-antibody reaction.

¹ Rocha e Silva, M., and Aronson, M., *Brit. J. Exp. Path.*, 33, 577 (1952). Rothschild, A. M., and Rocha e Silva, M., *ibid.*, 35, 507 (1954).

² Briot, M., and Halpern, B. N., *C.R. Soc. Biol.*, 148, 19 (1952).

³ Feldberg, W., and Talesnik, J., *J. Physiol.*, 120, 550 (1953).

⁴ Schachter, M., and Talesnik, J., *J. Physiol.*, 118, 258 (1952).

⁵ Ovary, Z., *Int. Arch. Allergy*, 3, 293 (1952).

USE OF SOLUBILIZING AGENTS IN GAS-PHASE PARTITION CHROMATOGRAPHY

By J. H. PURNELL and M. S. SPENCER

Department of Physical Chemistry, Free School Lane,
Cambridge

THE increasing number of publications relating to gas-phase partition chromatography illustrates the remarkable utility of this technique, and the descriptions of the separation of complex mixtures indicate the power and simplicity of the method. Increased column efficiency is generally obtained by increased column length and diminished particle size of the support material. These expedients, however, lead to a reduction of the rate of flow, resulting in a corresponding increase in the time required for analysis and greater diffuseness of the eluted bands. In order to overcome this, higher pressures and higher operating temperatures can be employed, but the latter may well lead to a reduction in column efficiency.

It is therefore desirable to operate the column at as low a temperature as possible and also at relatively low pressures, while maintaining column efficiency and rapidity of elution.

In an attempt to improve column operation in this direction, we have considered the possibility of modifying the stationary solvent in such a way as to lead to greater differentiation in the retention volumes of the eluted materials, and in this connexion, the great increase in solvent power resulting from the addition of, for example, the soaps or fatty acids, to a solvent led us to carry out experiments with columns of this type.

Table 1

	CH ₃ Cl	CH ₂ Cl ₂	CHCl ₃	CCl ₄
Vapour pressure (mm. mercury)	3,610	348.9	159.6	91.0
Solubility (gm./100 gm. water)	0.61	2.00	0.82	0.077
Retention volume in ml. nitrogen:				
Col. 1	17	56	71	103
Col. 2	12	30	34	38
Col. 3	15	57	134	194
Col. 4	35	266	793	1,670
Col. 5	45	315	951	1,960
Col. 6	71	406	1,220	2,550

In their original publications, James and Martin^{1,2} describe the improvement effected in the separation of fatty acids by the addition of stearic acid to the stationary solvent. The 'tailing' of the peaks is reduced very markedly, and the retention volumes are increased. These authors attribute the improvement to a decrease in the extent of self-dimerization of the eluted acids in the stationary phase. In the present work, we have used systems in which such an explanation is not possible, and we present here some preliminary results.

All the columns used were, so far as possible, identical in length and packing density, the solvents being supported on 120-mesh kieselguhr packed in tubing of 6 mm. internal diameter. In order to obtain definite evidence of solubilization, it was decided to use a system in which any separation due to vapour pressure differences would tend to be diminished by differences of solubility. A suitable system is that comprising the chloromethanes with water as the solvent. The vapour pressures, solubilities in water and retention volumes on the various columns used, all at 20° C., are listed in Table 1.

From the vapour pressure data, it appeared that some separation could be expected on a 'dry' kieselguhr column, and it was also possible that adsorption

might play some part. The elution of a mixture on such a column (column 1) is shown in Fig. 1a, while Fig. 1b shows the elution of the same mixture on a column (2) of water on kieselguhr (20/80 by weight). It can be seen that the 'dry' column is the more effective, the retention volumes being smaller on the water column, and increasingly so with decreasing vapour pressure. Since carbon tetrachloride is almost completely insoluble in water, it is evident that there is some degree of adsorption on the dry column. These results indicate the inefficiency of water as a solvent for these materials. The use of a 60/40 by weight 'Teepol'/water mixture (column 3) as solvent results in a large increase in the retention volumes, and elution occurs in the order of increasing chlorine content of the molecule, as can be seen in Fig. 1c.

Since the columns were of equal length and packing density and the use of water alone cuts down adsorption, it appears that the great improvement obtained by use of the mixed solvent is due to enhanced solubility.

This point of view may be used to interpret some results we obtain in non-aqueous media. In Table 1 are listed the retention volumes of the chloromethanes at 20° C. on the various columns used. Column 4 consisted of liquid paraffin on kieselguhr, while in column 6 the liquid paraffin contained 17.5 per cent by weight of stearic acid. It was found that the inclusion of the stearic acid in the stationary solvent made it impossible to obtain the same packing density, and consequently, the material in column 4 was extracted and repacked in narrower tubing (column 5) to the same length as column 6. Columns 1-6 contained the same weight of kieselguhr, while columns 4 and 6 contained the same weight of both kieselguhr and liquid paraffin.

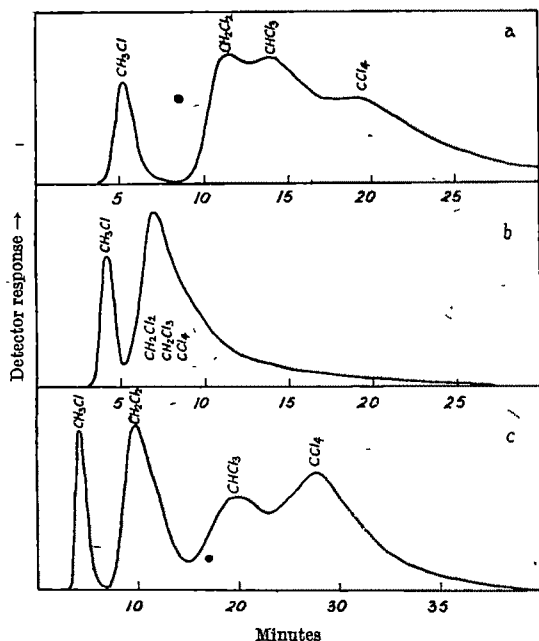


Fig. 1. Elution by nitrogen at 20° C. of chloromethanes on 38-cm. columns: (a) kieselguhr (6.3 ml./min.); (b) water/kieselguhr (6.3 ml./min.); (c) water/Teepol/kieselguhr (7.7 ml./min.).

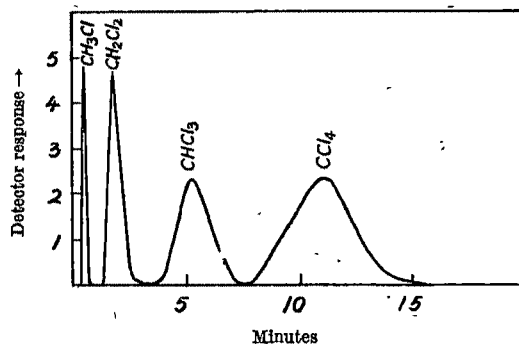


Fig. 2. Separation of chloromethanes at 20° C. on 12-cm. column of liquid paraffin/stearic acid/kieselguhr; flow-rate, 76 ml./min. of nitrogen

It can be seen from Table 1 that the retention volumes are increased by addition of stearic acid, and it is found that the peaks obtained are considerably sharper. This leads to a much cleaner separation; the increased efficiency is illustrated in Fig. 2, which depicts the separation of the chloromethanes on a column only 12 cm. long in the short time of 15 min.

This, and related work, will be discussed at greater length elsewhere. We thank Prof. R. G. W. Norrish and Dr. P. G. Ashmore for their encouragement, and one of us (M. S. E.) thanks the Department of Scientific and Industrial Research for a maintenance grant.

[March 21

¹ James, A. T., and Martin, A. J. P., *Biochem. J.*, 50, 679 (1952).

² James, A. T., and Martin, A. J. P., *Analyst*, 77, 359 (1952).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relation of Leuco-anthocyanins to Anthocyanin Synthesis

AMONG the herbaceous plants which Bate-Smith and Lerner¹ have recently found to contain leuco-anthocyanins were *Impatiens noli-tangere* and *I. parviflora* of the Balsaminaceae. We have been investigating the genetic control of anthocyanin pigmentation in *Impatiens balsamina*, which has been reported previously to produce glycosides of pelargonidin, peonidin and malvidin². In the course of these studies we have obtained evidence that the leuco-anthocyanins may serve as precursors for the anthocyanin pigments. In view of current interest in the leuco-anthocyanins, this aspect of the work is presented here.

In all analyses, fresh or frozen plant parts were first extracted by boiling with 0.1 N hydrochloric acid, filtered, then boiled for 3–5 min. after the addition of an equal volume of concentrated hydrochloric acid. This procedure hydrolyses any anthocyanins present and converts leuco-anthocyanins to anthocyanidins. The acid extracts were washed with ethyl ether to remove flavones and certain other substances. After removal of residual ether by boiling, the pigments were transferred by partition to a small volume of amyl alcohol, from which they were spotted or streaked directly on Whatman No. 1 paper for chromatography. Ascending chromatograms were used throughout, and solvents employed were *t*-butanol/acetic acid/water (15:2:5) and *m*-cresol/acetic acid/water (25:1:24)³. The phenolic phase of the latter mixture served as the mobile solvent, while the aqueous phase was included within the jars in an open dish. Pigments were identified by comparison with extracts of flowers of known pigment content, by Robinson's⁴ tests, and by comparison of R_F values with those reported by Bate-Smith. The sequence of spots corresponds to those reported by Bate-Smith, although the actual R_F values differ somewhat as a consequence of differences in technique and solvents employed.

Leuco-anthocyanins occur in balsams which have green stems and pure white flowers. The leuco-pigment of the stems yields cyanidin, whereas the petals and sepals contain in addition a leuco-anthocyanin which yields delphinidin.

Plants having the proper genotype produce violet-purple flowers and contain in both sepals and petals glycosides of malvidin. Buds (sepals and petals together) collected from these plants before any pigment is visible yield cyanidin and delphinidin from leuco-anthocyanins. Both leuco-anthocyanins disappear before the purple flowers mature.

Another combination of genes controls the production of bright red flowers. In this instance, petals contain only pelargonidin glycosides, whereas sepals contain both these pigments and some peonidin glycoside. Young colourless buds of this form contain leuco-anthocyanins which yield not only cyanidin and delphinidin but also pelargonidin. The leuco-pigments which correspond to cyanidin and delphinidin disappear before the flowers mature. While it is probable that the leuco-anthocyanin yielding pelargonidin also disappears during development of

the flowers, this leuco-pigment cannot be detected in the presence of pelargonidin by present techniques. The appearance in young, unpigmented buds of a leuco-anthocyanin convertible to pelargonidin is invariably associated with the presence of a specific dominant gene which also governs the production of pelargonidin glycosides in mature flowers.

Pelargonidin, however, is also produced under the influence of still another gene when in the proper genetic background. Since this gene does not govern the production of the corresponding leuco-anthocyanin in early stages of the bud, we conclude that the final stages of pelargonidin synthesis may follow alternative routes.

These results provide two separate indications that leuco-anthocyanins serve here as precursors for the ultimate anthocyanins. (1) Those leuco-anthocyanins which do not correspond directly with the ultimate pigment disappear as anthocyanins develop. Leuco-anthocyanins do not disappear during the maturation of white flowers, hence the disappearance of leuco-anthocyanins and appearance of anthocyanins are controlled by the same genes. Simmonds⁵ has reported a somewhat similar situation in developing bracts of the inflorescence of bananas, where non-methylated leuco-anthocyanins disappear as methylated anthocyanins appear. (2) Under the influence of a gene which has the principal effect of producing pelargonidin derivatives in mature flowers, a corresponding leuco-anthocyanin appears in colourless buds.

R. E. ALSTON

College of William and Mary,
Williamsburg, Virginia.

C. W. HAGEN, JUN.

Indiana University,
Bloomington, Indiana.
Jan. 27.

¹ Bate-Smith, E. C., *J. Exp. Bot.*, **4**, 1 (1953); *Biochem. J.*, **58**, 122 (1954). Bate-Smith, E. C., and Lerner, N. H., *Biochem. J.*, **58**, 126 (1954).

² Beale, G. H., Price, J. R., and Sturgess, V. C., *Proc. Roy. Soc., B*, **130**, 113 (1941). Hayashi, K., Abe, Y., Noguchi, T., and Sasashino, K., *Pharm. Bull.*, **1**, 130 (1953). Forsyth, W. G. C., and Simmonds, N. W., *Proc. Roy. Soc., B*, **142**, 549 (1954).

³ Bate-Smith, E. C., *Symp. Biochem. Soc.*, No. 3, 62 (1949).

⁴ Robinson, G. M., and Robinson, R., *Biochem. J.*, **25**, 1687 (1931).

⁵ Simmonds, N. W., *Nature*, **173**, 402 (1954).

Nature of a Hemicellulose extracted from Cellulose with Water

DURING the course of investigations leading to the development in this laboratory of the phenol-sulphuric acid procedure for the quantitative determination of sugars¹, small amounts of water-soluble carbohydrate impurities were detected in the paper (Whatman No. 1) used for separating mixtures of sugars.

We have now isolated enough of this water-soluble carbohydrate material from Whatman No. 1 filter paper to permit a more detailed examination of it. Smaller amounts of a similar material have been extracted from cotton linters and from purified wood α -cellulose.

The material, which is polysaccharide in nature, may be extracted at room temperature either by chromatographic irrigation or by simple extraction in water. When chromatographic irrigation is used, the water-soluble polysaccharide appears in the very first portion of the eluate. After re-drying in air, the same piece of filter paper will provide more

material when irrigated with water a second time; this process can be repeated many times. During the application of six alternate extraction and drying treatments to a larger sample of cellulose, it was found that the amount of material extracted remained constant after the second or third extraction (see Table 1). The material was isolated by concentration of the aqueous extract and precipitation with ethanol. The crude material showed $[\alpha]_D^{20} - 30^\circ$ (approx.) in water and after purification via its acetate ($[\alpha]_D^{21} - 42^\circ$ in formamide; OAc, 36.0 per cent) it had $[\alpha]_D^{20} - 53^\circ$ in water. Hydrolysis of the polysaccharide with *N* sulphuric acid yielded a syrupy hydrolysate ($[\alpha]_D^{20} + 43^\circ$ in water) which was shown to contain xylose (53.6 per cent), arabinose (15.8 per cent), glucose (11.1 per cent), galactose (1.9 per cent) and two acidic components which from their R_F values appeared to be a uronic acid (13.6 per cent) and an aldobiuronic acid (4.1 per cent). In some samples there have been indications of the presence of rhamnose. The quantitative chromatograms were developed with butanol/acetic acid/water² and pyridine/ethyl acetate/water³, and the sugars determined by the phenol-sulphuric acid method¹. The amount of the acidic components was determined approximately by reference to a standard glucose curve pending their complete identification. By prolonged extraction of cellulose with water, Adams and Bishop⁴ have also obtained a polysaccharide composed of arabinose (16.2 per cent), xylose (35.0 per cent), glucose (41.5 per cent) and galactose (7.55 per cent).

Table 1. EXTRACTION OF HEMICELLULOSE FROM CELLULOSE (1,000 GM. WHATMAN No. 1 FILTER PAPER) WITH WATER AT 25° C.

Extraction No.	Weight of extract (gm.)
1	0.28
2	0.16
3	0.15
4	0.09
5	0.09
6	0.09

The polysaccharide extracted from cellulose with water is now being subjected to methylation studies. The present evidence indicates that it is a pentosan containing uronic acid units as well as neutral sugars, and it appears to be similar to those found in many types of wood. Strachan⁵ observed a similar phenomenon with highly purified celluloses, but attributed it to a slight solubility of cellulose in water.

While this water-soluble polysaccharide extractable from Whatman No. 1 filter paper is of interest because of its interference in microquantitative paper chromatography and in the separation of substances by sheet paper and cellulose column chromatography, it is believed that some of the peculiar and as yet unexplained properties of cellulose and its derivatives (for example, its acetate and its xanthate) may be due to this or similar water-soluble polysaccharides that are with difficulty released from the cellulose by a process of autohydrolysis induced possibly by the acidity of uronic acid units. The phenomenon also appears to be related to the deterioration of cellulose caused by alternate wetting and drying⁶ and by the action of ozone at high moisture-levels⁷.

The part played by hemicelluloses that are known to be difficult to remove from cellulose still remains to be ascertained. The Whatman No. 1 filter papers used in this work also contained non-carbohydrate material which could be extracted with methanol. This material, which is probably a better additive, may cause difficulty when paper chromatography is

employed for the separation of sugars. Further details of this work will appear elsewhere.

We are indebted to the U.S. Army Ordnance Corps for their support of this work under contract No. DA-11-022-ORD-999.

G. W. HUFFMAN
P. A. REBERS
D. R. SPRIESTERSBACH
F. SMITH

Institute of Agriculture,
University of Minnesota,
St. Paul 1, Minnesota.
Jan. 28.

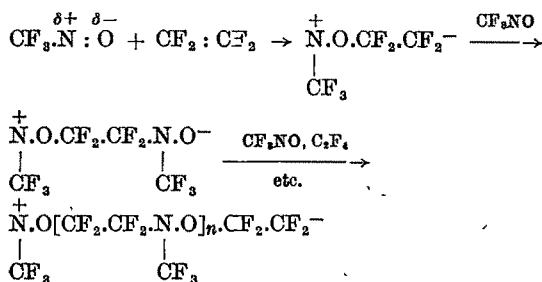
- ¹ Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A., and Smith, F., *Nature*, **168**, 187 (1951).
- ² Partridge, S. M., *Biochem. J.*, **42**, 238 (1948).
- ³ McFarren, E. F., Branc, Kathleen, and Butkowski, H. R., *Anal. Chem.*, **23**, 1146 (1951).
- ⁴ Adams, C. A., and Bishop, C. T., National Research Council, Ottawa, Canada (private communication).
- ⁵ Strachan, J., *Nature*, **143**, 332 (1938).
- ⁶ Bogaty, H., Campbell, L. S., and Appel, W. D., *Text. Research J.*, **22**, 75 (1952). Bone, W. A., and Turner, H. A., *J. Soc. Dyers and Colourists*, **63**, 3-5 (1950).
- ⁷ Bogaty, H., Campbell, E. S., and Appel, W. D., *Text. Research J.*, **22**, 81 (1952). Dorée, C., and Healy, A. C., *J. Text. Inst.*, **29**, T, 27 (1938).

A New Type of Copolymer

TRIFLUORONITROSOMETHANE, a deep blue monomeric gas^{1,2}, combines quantitatively with tetrafluoroethylene in the dark at -45° to give perfluoro-

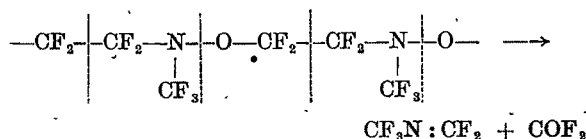
2-methyl-1 : 2-oxazetidine, $\text{CF}_3\text{N.O.CF}_2\text{CF}_2$ (30 per cent), and an involatile colourless viscous oil (65 per cent). The oil is insoluble in the common organic solvents, and is unaffected by hot concentrated sulphuric acid or hot concentrated aqueous potassium hydroxide; its infra-red spectrum fails to show the

presence of groups such as N:O, NO₂, N⁺(O⁻), ONO, ONO₂, C:C, N:N or C:N. The oil has the same empirical formula as perfluoro-2-methyl-1:2-oxazetidine, C₃NOF₇, showing a 1:1 ratio of trifluoronitrosomethane to tetrafluoroethylene. The oil is in fact a 1:1 copolymer of the reactants, formed by an ionic mechanism favoured by low temperatures:



The formation of perfluoro-2-methyl-1 : 2-oxazetidine from the intermediate $\text{CF}_3\cdot\text{N}\cdot\text{O}\cdot\text{CF}_2\cdot\text{CF}_2\cdot$ is also readily visualized by this mechanism. Chain termination in the polymer might involve disproportionation to give $\text{NF}(\text{CF}_3)_2$ and $\text{CF}:\text{CF}_3$ end-groups.

The polymer is readily soluble in perfluoromethylcyclohexane, and the mean molecular weight is much greater than 7,000. Support for the constitution of the polymer is given by the fact that when heated *in vacuo* at 400° in absence of air, the polymer yields equimolar amounts of perfluoro(methylenemethylamine) and carbonyl fluoride quantitatively:



This appears to be the first example of an N:O group acting like C:C in copolymerization, although it has been shown² that free radical addition to N:O can occur.

D. A. BARR
R. N. HASZELDINE

University Chemical Laboratory,
Cambridge.

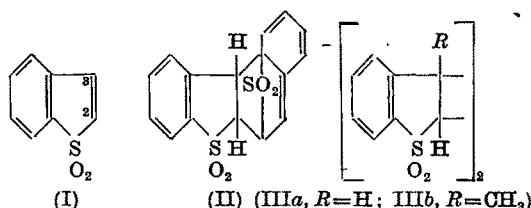
¹ Haszeldine, R. N., *Nature*, 168, 1028 (1951); *J. Chem. Soc.*, 2075 (1953).

² Haszeldine, R. N., and Jander, J., *J. Chem. Soc.*, 4172 (1953); 696, 912, 919 (1954); *Naturwiss.*, 22, 579 (1953).

Dimerization Reactions in Sunlight

THE investigations previously reported¹ have been continued and I wish to put the following facts on record. The photo-experiments mentioned below have been carried out in a sealed 'Pyrex' glass tube (Schlenk-tube²) in an atmosphere of dry carbon dioxide; in all cases the dark experiments were negative.

It seems possible that the 2-3 bond in benzothiophene/1-dioxide¹ would undergo an analogous photo-dimerization reaction, under comparable conditions, typical of the similarly situated bond in indone derivatives, for example, 2-methyl-3-phenyl-indone³. This is indeed the case. When a benzene solution of (I) is exposed to sunlight for three days (July), it forms the difficultly soluble colourless photo-dimer, melting point 296°, from acetic acid (78 per cent yield) (found: C, 57.6; H, 3.6; S, 19.1. C₁₆H₁₂O₂S₂ requires C, 57.8; H, 3.6; S, 19.2 per cent). The photo-dimer, believed to be (IIIa), sublimes readily at 300° under reduced pressure; a fact which excludes the possibility that it could be regarded as a 'Diels-Alder dimerization adduct (II)'⁴.



Similarly, 3-methylbenzothiophene 1-dioxide undergoes a photo-dimerization reaction when its benzene solution is exposed to sunlight for five days (January) to give the difficultly soluble colourless photo-dimer (IIIb), melting point 312° (82 per cent yield).

A detailed report of this work will be published elsewhere.

AHMED MUSTAFA

Chemistry Department,
Faculty of Science,
Cairo University. Jan. 24.

¹ Mustafa, *Nature* 163, 856 (1948); 166, 108 (1950). Schonberg and Mustafa, *Nature*, 153, 195 (1944); 160, 401 (1947). Mustafa and Islam, *J. Chem. Soc.*, 81 (1949).

² Schlenk and Thal, *Ber.*, 46, 2840 (1913).

³ De Fazi, *Gazz. chim. Ital.*, 54, 58, 300 (1924). Cf. also, Mustafa, *Chem. Rev.*, 51, 1 (1952).

⁴ Bordwell, McKellin and Babcock, *J. Amer. Chem. Soc.*, 73, 5566 (1951).

Inactivation of Phage due to Assimilated Phosphorus-32 and the Recovery of Host Cells

FROM experiments carried out by other authors¹, who have exposed to ultra-violet light and to X-rays bacteria infected with different types of phages (T2, T7), it has been possible to obtain a general picture of the changes which take place during the latent period, from infection to the lysis of the host cells. It was found, in agreement also with other types of experiments, that phage T2 begins to multiply only about 7-9 min. after infection. During this period the particle is not infectious and is responsible for the changes in the host cell which lead to the synthesis of new virus. Study of this early period might thus furnish important information about the relationships established between virus and host cell.

To this end we decided to study the inactivation of the phage BM (active on *B. megatherium*) strongly labelled with phosphorus-32, after its penetration into unlabelled cells suspended in a non-radioactive medium. A suitable freezing technique enabled us to stop the cellular metabolism at known times after infection. Our aims were to find: (a) possible variations in the rate of inactivation of radioactive phage before and after its penetration into the cell; (b) possible variations in the rate of inactivation as a function of the time elapsed from the adsorption to the lysis of the host (about twenty minutes); (c) a possible recovery of the cell following inactivation of the phage after its penetration. For details of the technique of freezing and of preparation of the radioactive phage, we refer to previous publications^{2,3}.

Repeated controls have shown that the frozen cells of *B. megatherium* survive completely this treatment. In order to measure the rate of inactivation of the radioactive phage within the cell, we chose a low infection ratio (0.2 phage per cell), so as practically to eliminate multiple events. The infection mixture was prepared so as to ensure an adsorption of 50 per cent of the phage in 1 min.; after this time, the mixture was diluted in antiphage horse serum so as to stop adsorption and inactivate the unadsorbed phage, the concentration and strength of the serum being such as to cause inactivation of 99 per cent of the free phage in 1 min. The mixture was then diluted in broth and aerated in a suitable vessel from which samples could be taken quickly every 30 sec. and immediately frozen. In this way we obtained cells infected almost simultaneously in which the development of the radioactive phage was arrested at known times; afterwards the frozen samples were tested periodically for inactivation of radioactive intracellular phage up to 40 days.

In order to study cell recovery following the penetration and inactivation of the radioactive phage, we used infection ratios of either 1 or 3; the samples were frozen 2 or 4 min. after infection, and tested on subsequent days by colony counts to ascertain the number of recovered cells.

The inactivation curves of the radioactive intracellular phage are quite similar for the first 5 min. after infection. This result was obtained consistently in four experiments, during which this interval was examined thoroughly every 30 or 60 sec. The average value of the inactivation-rate of the radioactive intracellular phage is $k = 6.0$ (Fig. 1), a value significantly different from, and some 40 per cent less than, the inactivation-rate of the free frozen phage ($k' = 9.3$ (see ref. 3)). We have examined the behaviour of the inactivation-rate after the fifth

minute up to the lysis of the cells, and this work will be reported elsewhere.

Fig. 2 is a graph of the number of recovered cells as a function of the dose $D = 1 - (\exp - \lambda t)$, where λ is the decay constant of phosphorus-32. On the hypothesis that the distribution of phages in the bacteria is Poissonian, with the mean value $\bar{I}$, and that the inactivated phage does not interfere with cell multiplication, one obtains the expression:

$$N(D) = \sum_{i=0}^{\infty} I^i (1 - \exp - kD)^i \frac{\bar{I}^i (\exp - \bar{I})}{i!} \left\{ a + \frac{2iA}{\exp \bar{I}} \right\}$$

$$= a \exp - \bar{I}(\exp - kD) + A \exp - 2\bar{I}(\exp - kD)$$

where k is the inactivation-rate of the radioactive phage during the 5 min. following infection and a and A represent the fractions of single cells and diplobacilli calculated with a phase-contrast microscope. The experimental points for the 2- and 4-min. samples are in good agreement, and the difference noticed does not seem significant. On the other hand, the points seem consistently lower than theoretical expectation (with $\bar{I} = 1$, $k = 6.2$, $a = 0.76$, $A = 0.24$), even when account is taken of the errors in the parameters which appear in the formula ($\Delta \bar{I} = 0.06$, $\Delta k = 0.02$, $\Delta A/a = 0.02$). This differ-

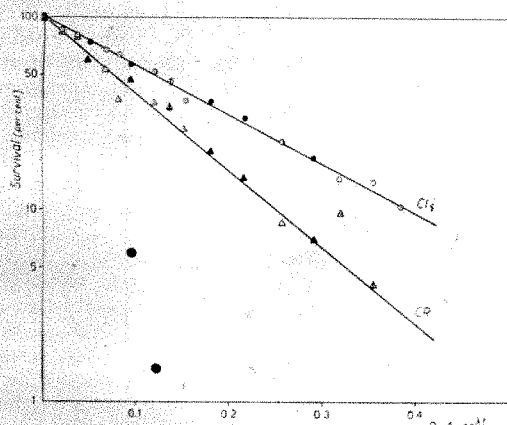


Fig. 1. Ordinate represents the phage survival (per cent); abscissa represents the dose D . Cl , labelled intracellular phage up to 5 min. after infection. CR , frozen labelled free phage

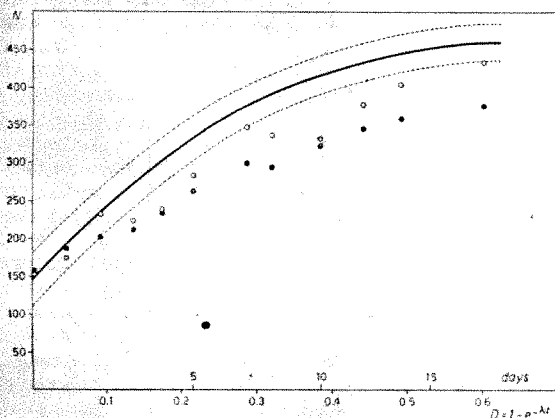


Fig. 2. Abscissa represents the dose and the ordinate represents the number N of colonies. The open and filled circles represent samples frozen 2 min. and 4 min. respectively after infection. The dotted lines represent the error on the theoretical curve (full-line curve) obtained from the errors on the parameters

ence can be explained either by assuming that some cells are damaged by the radioactive phage even after its inactivation (in disagreement with our hypothesis), or by assuming that cells infected by too large a number of particles are not capable of recovering (this effect, phage reactivation by multiple infection, has already been noticed by other authors for phages inactivated by ultra-violet light). An examination of the number of lytic centres as a function of D enables us to exclude the first assumption. On the other hand, taking the summations in the formula only for $0 \leq I \leq 4$ we obtain good agreement with the experimental results. This is confirmed by the much larger difference observed between experimental and theoretical values in the case of an infection ratio of 3-4 particles per cell.

These experimental results enable us to draw the following conclusions: (a) the fact that up to 5 min. after infection k does not vary indicates that there is no exchange between the phosphorus of the phage deoxyribonucleic acid and that of the host cell (that is, the phage deoxyribonucleic acid is not metabolized, at least during this period), and suggests that the genetic structure of the phage has a considerable independence in the host; (b) the difference found in the inactivation-rate before and after penetration of the phage into the cell can be explained either by supposing that a part of the phage phosphorus is lost during the infection, or that intracellular phage becomes less sensitive.

Our results suggest that in this phage system infection does not mean the suppression of the reproductive ability of the cell; moreover, the fact that almost all the infected cells are able to recover following the penetration and inactivation of the phage (at least during the first 4 min.) seems to us of importance in estimating the damage produced during the first stages of virus infection.

C. CASTAGNOLI

Istituto di Fisica,

P. DONINI

F. GRAZIOSI

Istituto di Microbiologia,
Università di Roma.

Dec. 6.

¹ Latarjet, R., and Luria, E., *Ann. Inst. Past.*, 77, 666 (1947). Latarjet, R., *J. Gen. Physiol.*, 31, 529 (1948). Benzer, S., *J. Bact.*, 63, 59 (1952).

² Coppo, A., *N. Ann. Ig. Microbiol.* (in the press).

³ Castagnoli, C., and Graziosi, F., *Nature*, 174, 599 (1954).

Occurrence of Acid Phosphatase in Association with the Haustoria of Powdery Mildew on Barley

THE intracellular haustoria of rust (*P. graminis tritici* Erikss. and Henn.) and mildew (*E. graminis hordei* Marchal) are usually regarded as absorbing organs, which, in the case of rust at least¹, only invaginate the protoplasts of the host cells. The use of radioactive tracers has shown that phosphate^{2,3}, sugars and products of carbon dioxide fixation³ accumulate in infections of these obligate parasites, and the suggestion has been made that the pathogens require phosphorylated intermediates of host metabolism⁴.

As part of a cytochemical investigation of haustorial development, we have examined the distribution of acid phosphatase in mildewed barley epidermis. The

observations were carried out with mildew rather than with rust, because the former is an ectoparasite and its characteristic digitate haustoria are normally confined to the non-chlorophyllous epidermal cells which are low in phosphatase activity. Moreover, suitable material for cytochemical examination can be readily obtained in the form of epidermal strips, so that paraffin embedding and sectioning are not necessary. Three techniques for acid phosphatase were employed, namely, (1) Yin's modification of the Menten-Junge-Green method⁵, (2) Gomori's revised method⁶, (3) Burton's azo-dye method in which rapid coupling, indicated by the formation of a black dye, is believed to eliminate diffusion artefacts⁷. In all cases fixation was carried out for 2 hr. in 80 per cent ethanol.

The Menten-Junge-Green method was abandoned after preliminary trials, which did, however, show that phosphatase was concentrated in association with the haustoria. In general, the Gomori method strikingly confirmed this preliminary result. Figs. 1 (ungerminated conidium), 2 and 3 (haustoria) illustrate the results obtained by the Gomori method. Occasional negative results with individual haustoria (Fig. 3) are assumed to be due to the vagaries of the technique⁸. The Burton method (Fig. 4) gave similar and more consistent, if somewhat less striking, results. The substrate, monosodium alpha-naphthyl acid phosphate, was prepared by the method of Friedman and Seligman⁹. Our results with plant material differ in one important respect from those reported by Burton for animal tissue, in that nuclei gave a positive reaction for acid phosphatase, as may be seen from Fig. 5. With all three techniques, incubation after inactivation by steaming or in the absence of substrate gave negative results.

It is concluded that relatively high concentrations of acid phosphatase occur within or on the haustoria

of mildew, and that the agreement between the Burton and Gomori methods shows that the latter is satisfactory for use with our material. It is thought that these fungal enzymes may play an important part in the transfer of metabolites between host and parasite.

The critical application of cytochemical methods, especially those for demonstrating enzymes, might constitute a fruitful approach to many problems in physiological plant pathology and the study of disease resistance.

We are grateful to the National Research Council for financial support.

T. G. ATKINSON
M. SHAW

Department of Biology,
University of Saskatchewan.
Jan. 3.

¹ Thatcher, F. S., *Can. J. Res.*, C, 21, 151 (1943).

² Gottlieb, D., and Garner, J. M., *Phytopath.*, 36, 557 (1946).

³ Shaw, M. Brown, S. A., and Jones, D. Rudd, *Nature*, 173, 768 (1954).

⁴ Cutter, V. M., *Trans. N.Y. Acad. Sci.*, 14, 103 (1951).

⁵ Yin, H. C., *New Phytol.*, 44, 191 (1945).

⁶ Gomori, G., *Stain Tech.*, 25, 81 (1950).

⁷ Burton, J. F., *J. Histochem. and Cytochem.*, 2, 38 (1954).

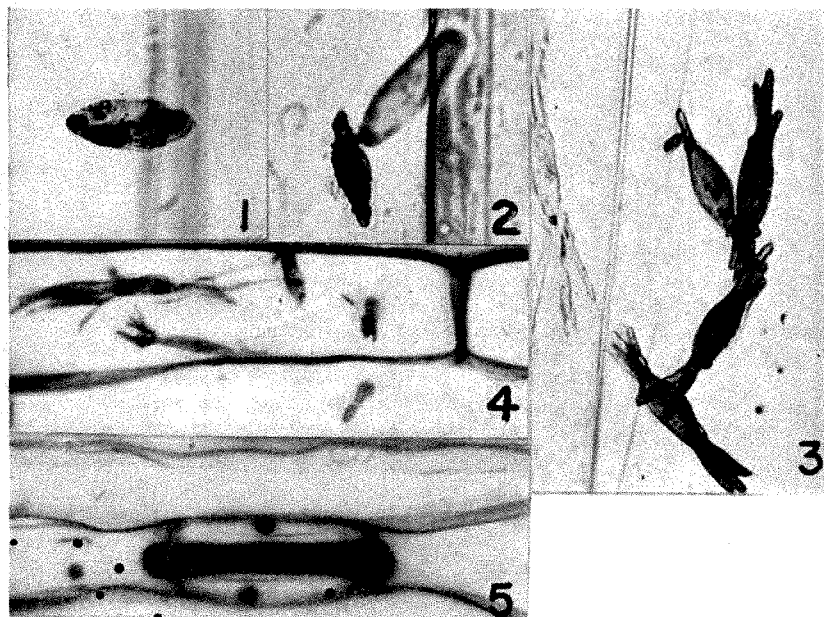
⁸ Gomori, G., "Microscopic Histochemistry" (Univ. Chicago Press, 1952).

⁹ Friedman, O. M., and Seligman, A. M., *J. Amer. Chem. Soc.*, 72, 324 (1950).

Formation of 5-Hydroxytryptophan from Tryptophan by *Chromobacterium violaceum*

PREVIOUS reports from this laboratory have established tryptophan as the dietary precursor of 5-hydroxytryptamine¹. The demonstration of the widespread occurrence of a specific decarboxylase for 5-hydroxytryptophan² suggested that this hitherto unknown amino-acid was the intermediate, and that tryptophan was hydroxylated to 5-hydroxytryptophan in a manner analogous to the hydroxylation of phenylalanine to tyrosine. Although experiments with carbon-14 tryptophan resulted in slight labelling of added carrier 5-hydroxytryptophan, the conversion in mammalian and invertebrate tissues was too small for definite identification. The recent identification of violacein, the pigment of *Chromobacterium violaceum*, as a 5-hydroxyindole derivative³ led us to investigate the metabolism of tryptophan by this organism.

The bacteria were grown in glucose-yeast extract medium for 24 hr. The cells were harvested, washed twice, and incubated with tryptophan. Table 1 shows the amounts of 5-hydroxytryptophan formed in the course of such incubation. For the purpose of identifying the product derived from L-tryptophan, 300 ml. of the incubation mixture was lyophilized after centrifugation. The dried



Figs. 1-3. *E. graminis* at various stages of development on barley. Gomori method for acid phosphatase using sodium-glycerophosphate as substrate. (1) Ungerminated conidium; (2) young haustorium with attached conidium; (3) digitate haustoria. Incubated 1-2 hr. at pH 5.0 and approximately 21° C.

Figs. 4-5. Burton's azo-dye method for acid phosphatase. (4) Haustoria of *E. graminis*; (5) barley epidermis showing nuclear staining. Incubated 8 hr. and 2 hr. respectively at pH 5.6-5.7 and 37° C.

Table 1

	6 hr.	12 hr.	24 hr.	36 hr.
30 mgm. of L-tryptophan*	0.00	0.00	0.00	0.00
30 mgm. of D-tryptophan	0.06	0.11	0.25	0.33
10 mgm. of L-tryptophan	0.17	0.38	0.68	0.46
30 mgm. of L-tryptophan	0.22	0.50	0.93	1.16

* 0.45 gm. (wet weight) of *Chromobacterium violaceum* was shaken with tryptophan in 0.1 M phosphate buffer pH 6.0 at room temperature in a final volume of 15 ml. Figures are expressed in terms of mgm. of 5-hydroxytryptophan formed in 15 ml. These values are minimal, since 5-hydroxytryptophan is destroyed during incubation.

* Bacteria were placed in boiling water bath for 3 min. prior to incubation.

Table 2

	Synthetic 5-hydroxytryptophan	Isolated 5-hydroxytryptophan
<i>Paper chromatography</i>	<i>R_F</i>	<i>R_F</i>
<i>n</i> -Propanol/1 N ammonia (5:1)	0.12	0.12
<i>n</i> -Butanol/1 N hydrochloric acid	0.23	0.23
Phenol/water	0.44	0.43
<i>Spray reagent</i>	Colour	Colour
<i>p</i> -Dimethylaminobenzaldehyde	Blue → Green	Blue → Green
Ultra-violet fluorescence	Pink	Pink
Ninhydrin	Blue	Blue
Nitroso-naphthol	Purple	Purple
Naphthoquinone-sulphonate	Tan	Tan

Table 3

	Amount of substrate incubated (μM)	5-Hydroxytryptamine formed (μM)	Conversions* (per cent)
5-Hydroxy-D-L-tryptophan	1.20	0.64	53
(synthetic)	0.80	0.40	50
Isolated	0.54	0.45	85
5-hydroxytryptophan	0.33	0.30	91

* Corrected for small amount of 5-hydroxytryptamine destroyed during incubation.

residue was extracted with 0.01 N hydrochloric acid in 90 per cent methanol and chromatographed as a streak in butanol/acetic acid/water (5:1:4). The apparent 5-hydroxytryptophan was located by its pink fluorescence under ultra-violet light after spraying with dilute hydrochloric acid, cut out, eluted and rechromatographed in *n*-propanol/1 N ammonia (5:1). The 5-hydroxytryptophan was again cut out, eluted, and assayed colorimetrically⁴.

The behaviour of the isolated material on paper chromatograms and with certain colorimetric reagents was indistinguishable from that of authentic 5-hydroxytryptophan (Table 2). Incubation of the isolated material with crude 5-hydroxytryptophan decarboxylase yielded approximately the theoretical amounts of 5-hydroxytryptamine (Table 3). 5-Hydroxy-D-L-tryptophan yielded only 50 per cent of the theoretical amount of 5-hydroxytryptamine, indicating the optical specificity of the enzyme and suggesting that the isolated material was 5-hydroxy-L-tryptophan. Paper chromatography of the enzymatically formed 5-hydroxytryptamine produced single spots with *R_F* 0.62 in *n*-propanol/1 N ammonia (5:1) and *R_F* 0.23 in *n*-butanol/1 N hydrochloric acid. Authentic 5-hydroxytryptamine gave the same *R_F* values. The product formed after incubating with D-tryptophan has not yet been identified.

On the basis of this evidence, it would appear that the metabolite of L-tryptophan produced by *Chromobacterium violaceum* is 5-hydroxy-L-tryptophan. Conclusive proof of the L-configuration and further information concerning its physical properties must await isolation of larger quantities of the amino-acid.

We are grateful to Dr. Ralph De Moss for making available to us cultures of *Chromobacterium violaceum* (A.T.C.C. No. 553).

CHOZO MITOMA
HERBERT WEISSBACH
SIDNEY UDENFRIEND

Laboratory of Chemical Pharmacology,
National Heart Institute,
National Institutes of Health,
Bethesda, Maryland.
Jan. 24.

¹ Udenfriend, S., and Weissbach, H., *Fed. Proc.*, 13 412 (1954).

² Clark, C. T., Weissbach, H., and Udenfriend, S., *J. Biol. Chem.*, 210, 139 (1954).

³ Beer, R. J. S., Jennings, B. E., and Robertson, A., *J. Chem. Soc.*, 2679 (1954).

⁴ Udenfriend, S., Weissbach, H. and Clark, C. T., *J. Biol. Chem.* (in the press).

Effect of Decycorticosterone on the Reticulo-Endothelial System

THE reticulo-endothelial system is known to be an important defence mechanism against malignant growths in general¹. Nicol, Helmy and Abou-Zikry² showed that oestrogens, especially in combination with orchidectomy, stimulate the reticulo-endothelial macrophages in the liver, spleen and lymph nodes and appear to lead to mobilization of the macrophages in these organs. It is probable that such stimulation increases the general defence of the body against tumour growth.

In contrast, Nicol and Snell³ showed that cortisone, a gluco-corticoid, depresses the activity of the reticulo-endothelial system, especially in the spleen, and suggested that this was the probable explanation for patients treated with cortisone being more susceptible to infection, and the probable reason for cortisone enhancing the spread of transplanted tumours in animals. This may also explain the prolonged remissions which sometimes occur in patients with lymphosarcoma or Hodgkin's disease⁴ being treated with cortisone, for both diseases are characterized by pathological proliferation of the reticulo-endothelial system.

In view of the increasing use of hormones in the treatment of carcinoma and the apparent ineffectiveness of deoxycorticosterone, a mineral corticoid, in the treatment of Hodgkin's disease⁵, it seemed desirable to study the effect of this hormone on the reticulo-endothelial system.

Twenty-five male guinea pigs, aged about one year, were used in the present investigation. The reticulo-endothelial macrophages were studied by giving all the animals one daily injection of trypan blue subcutaneously for the last six days prior to being killed by chloroform. The dosage of the dye was calculated on the basis of 0.5 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. Seven of the animals were given dye only and were used as controls. The remaining animals were divided into three groups of six and given deoxycorticosterone acetate (Organon) in addition to the dye. Six animals received 2 mgm. of deoxycorticosterone intramuscularly once daily for one week; six received 2 mgm. daily for two weeks; and six received 5 mgm. daily for two weeks. Specimens were taken from the spleen, liver and lymph nodes and fixed in Heidenhain's 'Susa' fluid. Sections were cut at 10μ thick and stained with weak eosin, dilute carbol

fuchsin or alum carmine. The activity of the reticulo-endothelial system in the organs studied was assessed by the number of dye-bearing cells and the intensity of the vital staining.

In the group of animals which received 2 mgm. of deoxycorticosterone daily for one week, four showed vital staining appearances similar to those of the controls; the remaining two animals showed reduced activity of the macrophages, especially in the spleen and to a lesser extent in the liver and lymph nodes. In the group which received 2 mgm. of hormone daily for two weeks, five of the animals showed vital staining appearances similar to the controls, and the remaining one animal showed a slight reduction in phagocytic activity; similar results were found in the group which received 5 mgm. of the hormone daily for two weeks.

These preliminary observations show that deoxycorticosterone has little or no effect on the activity of the reticulo-endothelial macrophages and in this respect greatly differs from cortisone. This difference in action between the mineral corticoid and the glucocorticoid is of great interest, and for this reason the effect of adrenocorticotrophic hormone on the reticulo-endothelial system is now being investigated.

T. NICOL

R. S. SNELL

Department of Anatomy,
King's College,
London, W.C.2.
Jan. 27.

¹ Kavetzki, R. E., and Diadjuscha, G. F., *J. Med. Ukrain.*, 7, 837 (1937). Stern, K., *J. Lab. Clin. Med.*, 26, 809 (1941).

² Nicol, T., Helmy, I. D., and Abou-Zikry, A., *Brit. J. Surg.*, 40, 166 (1952).

³ Nicol, T., and Snell, R. S., *Nature*, 174, 554 (1954).

⁴ Pearson, O. D., Ehel, L. P., Rawson, R. W., Dobriner, K., and Rhoads, O. F., *Cancer*, 2, 943 (1949). Pearson, O. D., Ehel, L. P., and Taibot, jun., T. R., *Bull. New York Acad. Med.*, 26, 236 (1950).

⁵ Frada, G., *Presse Méd.*, 58, 78 (1950).

Binocular Vision and Deep-Sea Fish

THE human binocular threshold is more than 10 per cent lower than the monocular one. This finding has been explained on a statistical basis by Pirenne¹, who assumed that the two eyes are independent. The extent to which binocular vision lowers the threshold depends on the relation between stimulus and response and on the absolute value of the threshold. The lower the threshold, the greater is the benefit.

An examination of a number of deep-sea fish²⁻⁵ suggests that these animals have binocular vision in order to achieve greater sensitivity. They have eyes which are large and tubular and which often protrude from the head like periscopes. The visual axes are generally parallel. In some cases, the fundi are lined with tapeta. Thus there are several indications that maximum visual sensitivity is the target; the reduction in the threshold afforded by binocular vision is in harmony with this design.

But an animal with eyes in front has a smaller visual field than an animal with one eye on each side of the head. Is binocular vision in deep-sea fish, therefore, worth the price paid for it in terms of increased vulnerability? The answer may lie in a consideration of the light-intensity range in which they live. A 10 per cent improvement in the threshold would be of small consequence to man, whose environment ranges in intensity over many log units. But a

similar small improvement might be highly appreciated in regions in which light is always at a premium. Thus at intensity-levels well above the monocular threshold, monocular views of two widely differing fields may be advantageous as compared with fused binocular views of similar fields because of the increased information afforded by the former system. But, intermediate to the monocular and binocular thresholds, there is a finite intensity-range where fused binocular vision is clearly an advantage: at such intensity-levels, it is better to be able to see a relatively small field than not to see a large one. Assuming that the eyes are independent, binocular vision may double the response near the monocular minimum⁶. Other physical devices, such as a colourless crystalline lens⁷, or the presence of a tapetum⁸, increase an animal's sensitivity only by a fraction of a log unit. Binocular vision in deep-sea fish may rank with such second-order factors, and none the less be of critical survival value.

There is some zoological evidence supporting this view. The explanation usually advanced for the position of an animal's eyes—namely, that the hunter has eyes in front, but the hunted at the sides—does not apply to deep-sea fish⁴. The generalization fails also with other fish, for example, sharks. At least three types of deep-sea fish with tubular eyes do not seem to be predators although their visual axes are parallel. They are *Opisthoproctus*, *Winteria* and *Dolichopteryx*. They have small toothless mouths. Their trunks are trapezoidal and thus unlikely to be capable of the swift movement characteristic of streamlined bodies. They have no photophores with which to attract prey. The correlation between feeding habits and the direction of the visual axes thus does not appear to be as rigid in the sea as it is on land, since there are predator fish with non-parallel axes, and also non-predators with parallel ones.

Maximum light sensitivity may therefore be added to predacity and manipulation⁹ as factors associated with binocular vision.

R. A. WEALE

Group for Research in the Physiology of Vision
(Medical Research Council),
Institute of Ophthalmology,
Judd Street,
London, W.C.1.
Feb. 24.

¹ Pirenne, *Nature*, 152, 698 (1943).

² Brauer, "Die Tiefseefische: Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*" (1906).

³ Contino, *Arch. Ophthalm.*, 140, 390 (1939).

⁴ Walls, "The Vertebrate Eye" (1942).

⁵ Marshall, "Aspects of Deep Sea Biology" (1954).

⁶ Pirenne, *Research*, 2, 259 (1949).

⁷ Weale, *Nature*, 173, 1049 (1954).

⁸ Weale, *J. Physiol.*, 119, 80 (1953).

Euphausiopsin, a New Photosensitive Pigment from the Eyes of Euphausiid Crustaceans

THE eyes of euphausiid shrimps contain large quantities of vitamin A¹. Fisher *et al.*¹ found a particularly high concentration of the vitamin in the eyes of *Euphausia pacifica*. These observations have led to speculation that vitamin A may play a part in euphausiid vision.

Live specimens of *E. pacifica* were dark-adapted in running sea water, and their eyes were removed in dim red light. The whole eyes were macerated with

ground glass and extracted in darkness with 2 per cent aqueous digitonin (pH 7.2). The extracts were cleared by filtration through sintered glass.

Fig. 1 (solid line) shows a typical absorption spectrum of an aqueous extract of dark-adapted *E. pacifica* eyes. After the initial measurements were made, the solution was left in the dark at 24° C. for 20 min. The absorption spectrum was then measured again (Fig. 1, closed circles). The two spectra were indistinguishable, and it was concluded that the extract was thermally stable (subsequent experiments proved fresh extracts to be stable in darkness at 20° C. for 8–10 hr.).

The solution was then exposed to sunlight for 20 min., after which time the absorption spectrum was redetermined; and a difference spectrum was obtained by subtracting the value of optical density for the bleached solution from that for the unbleached at each wave-length.

Absorption of visible wave-lengths by aqueous solutions from dark-adapted *E. pacifica* eyes is maximal at 463–468 m μ . The position of this maximum depends upon the ratio between the concentration of a photostable pigment, probably astaxanthin, and the concentration of a hitherto undescribed light-sensitive pigment. Identification

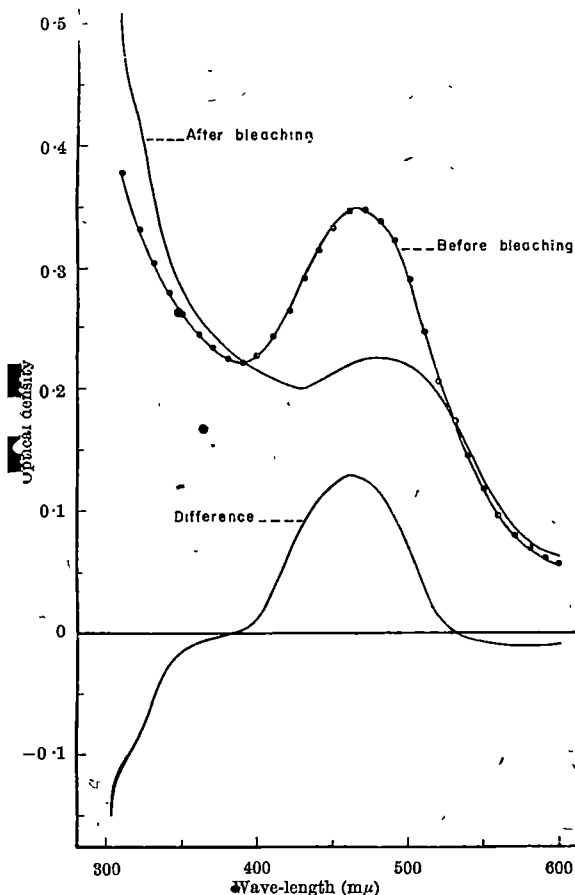


Fig. 1. Upper: Absorption spectrum of an extract of dark-adapted *Euphausia pacifica* eyes and of the same solution after 20 min. in darkness at 24° C. coincide (experimental points after 20 min. in darkness are marked ●). Absorption spectrum of the same solution after a 20-min. exposure to sunlight (marked, — after bleaching).

Lower: Difference spectrum obtained by subtracting optical densities after exposure to light from those before exposure to light at each wave-length.

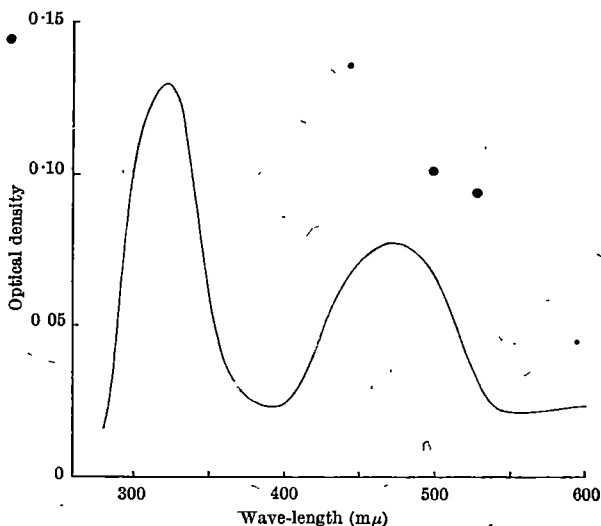


Fig. 2. Absorption spectrum of vitamin A₁ (325 m μ band) and astaxanthin (470 m μ band) in petroleum ether. This solution was obtained by extracting an aqueous extract of dark-adapted *E. pacifica* eyes with organic solvents (see text).

of the photostable contaminant as astaxanthin is supported by evidence obtained from mixed chromatograms and by the broad-band absorption in the blue-green (λ_{max} 470 m μ) by solutions of the contaminant in petroleum ether.

The greatest decrease in absorption caused by exposure to light occurs at 462 ± 1 m μ . Bleaching by light produces an increase in absorption in the ultra-violet. The slight hump at about 320 m μ on the direct absorption spectrum after bleaching and on the negative portion of the difference spectrum (Fig. 1) could be attributed to the release of vitamin A₁ during exposure to light.

The pigment is bleached by light of much lower intensity than that afforded by open sunlight. Difference spectra essentially identical with that shown in Fig. 1 have been obtained by placing samples of fresh extract in the light-path of the spectrophotometer for 3–4 hr. In these experiments the monochromator was set at 460 m μ , the slit width at 2 mm., and the temperature was controlled at 20° C. Heating a sample of fresh extract to 70° C. for 20 min. in dim red light caused precipitation and a marked decrease in spectral absorption in the visible range (maximal at 468 m μ) with an increase in absorption in the ultra-violet. After exposure to heat, the solution was no longer sensitive to light.

Samples of a fresh extract were treated with equal volumes of absolute methanol, acetone and chloroform, in darkness. Each trial resulted in coagulation and loss of light-sensitivity.

These observations indicate that the euphausiid photosensitive pigment contains a protein.

Destruction of the pigment by treatment with organic reagents results in a characteristic change in the absorption spectrum. Acetone was added to a sample of the aqueous extract, and the mixture was shaken with ethyl ether. After separation, the ether fraction was dried, and the residue was taken up in petroleum ether. This solution yielded an absorption spectrum (Fig. 2) with a broad band at 470 m μ , typical of astaxanthin, and a high, narrow peak at 325 m μ , characteristic of vitamin A₁. The presence of the vitamin in bleached samples of the aqueous extract was established by the Carr-Price reaction.

Retinene (vitamin A-aldehyde) was not detected in any of the extracts.

In summary, the photosensitive pigment from the eyes of euphausiids is water-dispersable and stable in the dark at 20° C. for periods up to 10 hr. It is decomposed in darkness, and its photosensitivity is lost by heating to 70° C. or by treatment with methanol, acetone or chloroform. Decomposition of the pigment, whether by light or by treatment with organic reagents, results in a loss of colour and an increased absorption in the ultra-violet. Inasmuch as every extract so far examined has been contaminated by astaxanthin, the new pigment is probably better characterized by its difference spectrum ($\lambda_{\text{max.}} 462 \pm 1 \text{ m}\mu$) than by any direct absorption data at present available.

The new photolabile pigment, described here from *Euphausia pacifica*, has been extracted from the eyes of two other euphausiid species. It is proposed that the pigment be called 'euphausiopsin', after the genus from which it was first extracted.

These studies are being continued under contract between the Office of Naval Research and the Scripps Institution. I am particularly grateful to the American Philosophical Society for providing, through a grant from the Penrose Fund, the Beckman Model DU spectrophotometer used in the work.

ELIZABETH M. KAMPA

Scripps Institution of Oceanography,
La Jolla, California.
Jan. 15.

¹ Fisher, L. R., Kon, S. K., and Thompson, S. Y., *J. Mar. Biol. Assoc. U.K.*, 31 (2), 229 (1952); 33 (3), 589 (1954); 34 (1), 81 (1955).

Depression in Brain Potassium in Ovine Pregnancy Toxæmia

A LOWERING of brain potassium has been demonstrated in insulin-induced hypoglycæmic encephalopathy in cats¹. As ovine pregnancy toxæmia has been tentatively identified as hypoglycæmic encephalopathy², determinations were made of the potassium content of slices, approximately 2 mm. thick, taken from the surface of the cerebral cortex of sheep dead, or *in extremis*, from either pregnancy toxæmia or prolonged insulin hypoglycæmia. Similar samples were taken from normal sheep.

The mean potassium content of brain slices from pregnancy toxæmia cases was significantly lower ($P < 0.001$) than that of the normal brains, and that of the brains of the insulinized sheep significantly lower ($P < 0.001$) than that of either of the other two groups. The association of a lower brain potassium in both pregnancy toxæmia and prolonged insulin hypoglycæmia is consistent with our tentative identification of ovine pregnancy toxæmia as a hypoglycæmic encephalopathy²; but in view of the evidence that *in vitro*, anoxia and low glutamate concentration can depress brain potassium and cooling can depress retina potassium³, it seems likely that any depression of cerebral metabolism may be accompanied by a lowered brain potassium. The decrease in brain potassium therefore does not provide unequivocal confirmation of the hypothesis; but as no other likely cause of cerebral depression has been found², hypoglycæmia remains as the most probable cause. The more marked depression of brain potassium in insulinized sheep reflects the more marked hypoglycæmia seen in these sheep compared

Table 1. POTASSIUM-CONTENT OF BRAIN SLICES

	No. of brains	No. of samples	Mean brain slice potassium* (m.mol./kgm. dry matter)
Normal	27	164	433 $\pm$ 3.3
Pregnancy toxæmia	16	120	388 $\pm$ 4.6
Insulin	5	40	314 $\pm$ 7.3

* Determined on a flame photometer after nitric-perchloric digestion of dried slices.

with developing pregnancy toxæmia cases (unpublished work).

Assuming a 70:30 distribution of water between intracellular and extracellular fluids⁴ and a concentration of about 5 m.mol./l. of potassium in the extracellular fluid of sheep⁵, the extracellular potassium would contribute about 1.5 m.mol./l. of wet brain or about 7 m.mol./kgm. of dry brain to the total brain potassium. Obviously, then, a depression of about 45 m.mol./kgm. in the potassium in the brain in pregnancy toxæmia and 119 m.mol./kgm. in insulin hypoglycæmia must be due largely to a depression in the intracellular potassium.

The loss in intracellular potassium is interpreted as being due to an insufficient supply of glucose to the cells, as has been shown to occur *in vitro*^{6,7}. As lowered potassium concentration has been shown to limit glucose uptake by brain slices *in vitro*⁷, the lowered brain potassium, once established, may be a reason for either spontaneous or induced reversal of the hypoglycæmia being ineffective as a means of relieving the symptoms unless it occurs early in the course of symptoms. The failure of sheep to show symptoms during short-term but extreme hypoglycæmias⁸ and the development of symptoms during less extreme but more prolonged hypoglycæmias⁹ may be explainable if prolonged hypoglycæmia is needed to depress the brain potassium. In view of the vital role of potassium in nerve transmission¹⁰, the level of potassium in the cells may be the direct cause of the cerebral dysfunction rather than the insufficient supply of glucose *per se*.

Where samples of whole brain were used for analysis, no significant differences in potassium levels could be demonstrated, in contrast to the results obtained with cerebral cortical slices. This supports the indication from clinical observation and fundamental considerations; as discussed², that only the higher nerve centres are involved in the hypoglycæmic encephalopathy of pregnancy toxæmia.

Acknowledgment is made to the Wool Research Trust Fund Account for financial assistance.

B. P. SETCHELL
G. L. MCCLYMONT

Nutrition Research Laboratory,
Veterinary Research Station,
Glenfield, N.S.W.
Jan. 19.

¹ Yarnet, H., *Arch. Neurol. Psych.*, 42, 237 (1939).

² McClymont, G. L., and Setchell, B. P., *Aust. Vet. J.* (in the press).

³ Ternor, C., Eggleston, L. V., and Krebs, H. A., *Biochem. J.*, 47, 139 (1950).

⁴ Marriott, H. L., *Brit. Med. J.*, 1, 245 (1947).

⁵ Setchell, B. P., and McClymont, G. L., *Aust. J. Agric. Res.* (in the press).

⁶ Dixon, K. C., *Biochem. J.*, 44, 187 (1950).

⁷ Ashford, C. A., and Dixon, K. C., *Biochem. J.*, 29, 157 (1935).
Dickens, F., and Greville, G. D., *Biochem. J.*, 29, 1468 (1935).

⁸ Reid, R. L., *Aust. J. Agric. Res.*, 2, 146 (1951).

⁹ Jarrett, I. G., and Potter, B. J., *Aust. J. Exp. Biol.*, 31, 311 (1953).
Jasper, D. E., *Amer. J. Vet. Res.*, 14, 209 (1953).

¹⁰ Hodgkin, A. L., and Huxley, A. F., *Cold Spring Harbor Symp. Quant. Biol.*, 17, 43 (1952).

Brucella abortus Strain 19 cultivated in Aerated Liquid Medium

AERATED liquid culture methods¹ have been evolved to produce *Brucella* vaccine for cattle at greatly reduced cost. The shake-flask technique was employed. Rectangular flasks of four-litre capacity, containing 450 ml. liquid culture, were agitated on a shaking machine at 64 excursions per min. of 12 cm. each. The medium² consisted of 3 per cent peptone, 3 per cent glucose, 1 per cent 'Marmite' (yeast extract), 0.16 per cent disodium hydrogen phosphate (mol. wt. 141.98), 0.03 per cent 'Anti-foam' (polyoxyethylene derivative of ricinoleic acid supplied by I.C.I., Ltd.) in tap-water; pH 6.4.

The medium was cleared through 'Speedex' filter powder over blotting paper and sintered glass (porosity No. 2), and sterilized by filtering through a 'Ford Sterimat' (Seitz EK) asbestos pad. The seed, a 48-hr. potato agar culture, suspended in buffered saline (0.021 M Na_2HPO_4 ; 0.045 M $\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$; 0.017 M NaCl; pH 6.4) was introduced by siphoning through a hooded pipette over a flame to produce a viable count of 500,000,000 organisms per ml. (see Fig. 1).

The growth was harvested after shaking for 66 hr. at 37.5° C. in the dark with the flasks fixed cross-wise at a slant of 1:50 upwards to the neck to allow for a semicircular reversing agitation. A bent hooded pipette was used to siphon the culture, containing at least 150×10^9 organisms per ml., into buffered saline diluent to make a vaccine suspension of about 30×10^9 organisms per ml. This was stored at 4° C. in 10-litre flasks while samples from each flask were being tested for pH, purity on culture, density,

viable count, S- to R-variation and tetrazolium reduction. Bulk samples of each group of batches were tested biologically for safety and immunizing quality. After bottling, purity tests were repeated in a separate laboratory.

The exponential phase of growth in this culture occurred between the twentieth and sixtieth hour of incubation (Fig. 1). S- to R-variation was not observed, and antigenicity tests consistently gave results identical with those of surface culture vaccine. Reactions produced in vaccinated animals were also identical. The output of the laboratory was increased tenfold by the adoption of this technique³.

I am indebted to Dr. R. A. Alexander, director of Veterinary Services, for encouragement and help.

G. C. VAN DRIMMELEN

Section of Bacteriology,
Onderstepoort,
Transvaal.
Nov. 4.

¹ Glassman, H. N., and Elberg, G. S., *J. Bact.*, 52, 423 (1946).

² McCullough, W. C., Miller, R. C., Herbst, T. E., Roessler, W. G., and Brewer, C. R., *J. Bact.*, 53, 5 (1947). Van Der Schaaf, A., *Tijdschr. Diergen.*, 73, 598 (1948).

³ Van Drimmelen, G. C., *J. S. Afr. Vet. Med. Assoc.*, 23, 149 (1952).

Production of Plaques with Influenza Viruses

THE demonstration of the production of plaques, that is, necrotic foci, in tissue culture with the viruses of Eastern equine encephalomyelitis¹, Western equine encephalomyelitis², Newcastle disease³, vaccinia⁴, and poliomyelitis⁵, offers additional quantitative applications to the study of these viruses. A necessary condition for the development of a plaque in tissue culture has been shown to be a destructive activity of the virus on the tissue employed. With the demonstration of a highly destructive effect of the WSE strain of influenza A virus on various chick embryonic tissues (9-day chorio-allantoic membrane, and 14-day lung and liver in roller tube cultures, unpublished results), experiments were undertaken to show production of plaques with this virus. Using the technique of Noyes⁶, plaques averaging 0.5 mm. in diameter were obtained in five days on chick embryonic layer tissue cultures with a high dilution of the allantoic fluids used. Attention was then directed to a less heterogeneous source of tissue, chick embryo lung. Plaque formation was shown to occur readily with this tissue not only with the WSE strain of influenza A virus, but also with the other influenza virus strains tested.

Lungs from thirty-six 14-day chick embryos were removed, washed twice with Earle's salt solution (BSS) and pressed into approximately 30 ml. of BSS through a wire mesh strainer having 10 strands per cm. After standing for 10 min. at room temperature, the supernatant containing cell debris was discarded. The sediment was resuspended in 18 ml. BSS (0.5 ml. BSS per one set of lungs) and rapidly pipetted twenty times with a 10-ml. pipette. The suspension was allowed to stand for 10 min. at room temperature, during which time the large particles settled into the bottom 1-2 ml. This was discarded, and the procedure repeated twice. The resulting preparation consisted mostly of a single-cell suspension. The cell concentration was determined in a haemocytometer and the suspension diluted with nutrient fluid (40 per cent horse serum heated to 60° C. for 30 min.; 20 per cent embryo extract (1:2 in BSS) made from 9-day

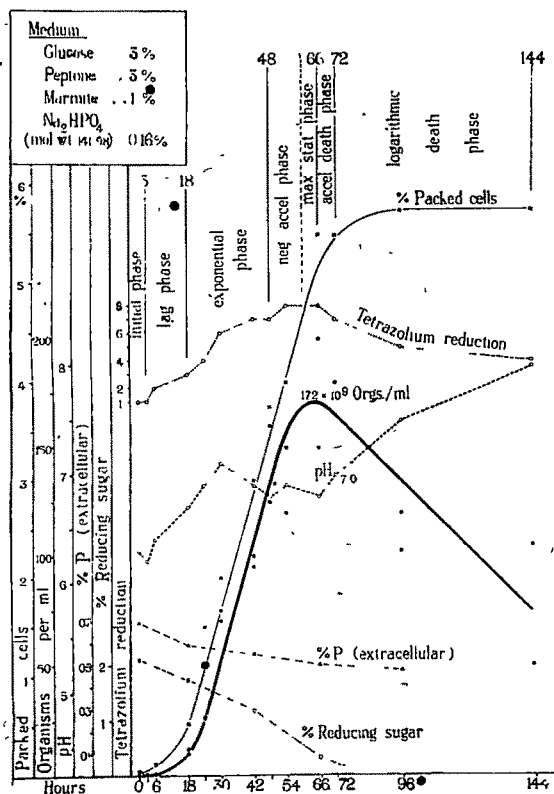


Fig. 1. Growth curve of *Brucella abortus* S.19 in shake-flask culture

chick embryos; 40 per cent BSS; 50 units of penicillin and 50 μ gm. of streptomycin added per ml.; pH approximately 7.6) to give a final cell concentration of approximately 4×10^6 cells per ml. Usually the cell suspension was diluted 1:2.5 with the nutrient fluid.

Aliquots of 2 ml. of the final cell suspension in nutrient medium were added to 40-mm. flat bottles and allowed to settle on a glass surface coated with a thin layer of chicken plasma clot. The cultures were incubated overnight at 35° C. The uniform cell layers were washed twice with 2 ml. of BSS, and a virus sample in 2 ml. BSS introduced into the bottle. After incubation for 1–2 hr. at 35° C., the fluid was removed and the cell layer was covered with a thin layer of plasma clot in order to produce more discrete lesions. 2 ml. of nutrient fluid consisting of 25 per cent chick embryo extract and 75 per cent BSS were added, and this was renewed at intervals of two or three days. After five days of incubation at 35° C., neutral red (chloride vital) in BSS was added to the nutrient fluid (at a pH of 6.8–7.0) to give a final concentration of 1:5,000, and incubation continued for two additional days.

At this time plaques could be seen as white, opaque foci averaging 0.5 mm. in diameter, with a range of approximately 0.3–1 mm., against the background of living cells stained with neutral red. (Because of the uneven thickness of the glass surface of the bottles used, satisfactory photographs could not be obtained. However, the photographs of Noyes, using vaccinia virus³, show comparable effects of virus concentration on staining with neutral red. The plaques produced by influenza viruses, under the experimental conditions used, are smaller than those produced by vaccinia virus.) That plaque production was due to viral activity was supported by the following: (1) plaques were absent when virus was absent; (2) specific antiserum inhibited the production of plaques; and (3) the number of plaques increased with the concentration of virus. With the exception of PR-8 virus, an approximate linear relationship between plaque count and the concentration of virus was reproducibly found.

Table 1 gives representative results of the testing of various influenza strains for their ability to produce plaques. Serial ten-fold dilutions were made of

allantoic fluid viruses harvested about 40 hr. after inoculation of 11-day chick embryos with a 10^{-6} dilution of the previous passage allantoic fluid. The tissue culture infectious units/ml. as explained below, the 50 per cent egg infectivity end-point⁵, and the last dilution of fluid producing haemorrhages in the chick embryo after chorio-allantoic membrane inoculation of 12-day chick embryos, expressed as the chorio-allantoic membrane inoculation titre⁶, are given. The figures are expressed as the reciprocal of the negative logarithms.

As shown in Table 1, all the influenza strains tested could produce plaques. There was no correlation between plaque production and the ability to induce haemorrhages in the chick embryo. Taking into consideration the forty-fold difference in volume of the virus inoculum used in the tissue culture procedure with that used in the egg infectivity titration (0.05 ml. of a virus inoculum used per egg), it would appear that the former technique was somewhat less sensitive than the egg procedure. However, the virus inoculum in the tissue culture system is removed 1–2 hr. after inoculation, at a time when possibly not all the infecting particles have become attached to susceptible cells.

Preliminary experiments of the comparative behaviour of WSE, Lee and PR-8 viruses in roller-tube cultures of 14-day chick embryo lung revealed that WSE and Lee viruses produced almost complete degeneration of the cellular outgrowth, while PR-8 virus caused only a partial destruction. This potential difference between the viruses used in their ability to cause destruction of the outgrowing cells from the heterogeneous population of lung tissue, as well as the finding that the number of plaques produced by PR-8 virus did not increase with virus concentration reproducibly, is under further investigation.

NADA LEDINKO*

Walter and Eliza Hall
Institute of Medical Research,
Melbourne.
Jan 21.

* Fellow of the National Foundation for Infantile Paralysis.

¹ Gey, G. O., and Bang, F. B., *Trans. N.Y. Acad. Sci.*, 14, 15 (1951).

² Dulbecco, R., *Proc. U.S. Nat. Acad. Sci.*, 38, 477 (1952).

³ Noyes, W. F., *Proc. Soc. Exp. Biol. and Med.*, 83, 426 (1953).

⁴ Dulbecco, R., and Vogt, M., *J. Exp. Med.*, 93, 167 (1954).

⁵ Cairns, H. J. F., and Edney, M., *J. Immunol.*, 69, 155 (1952).

⁶ Lind, P. E., and Burnet, F. M., *Aust. J. Exp. Biol. and Med.*, 32, 437 (1954).

⁷ Enders, J. F., *Proc. Soc. Exp. Biol. and Med.*, 82, 100 (1953).

⁸ Burnet, F. M., and Lind, P. E., *Aust. J. Exp. Biol. and Med.* (in the press).

Table 1. COMPARISON OF PLAQUE PRODUCTION AND EGG INFECTIVITY TITRATIONS USING VARIOUS INFLUENZA VIRUS STRAINS

Virus tested	Titration method		
	Tissue culture infectious units/ml.*	50% egg infectivity end-point	Chorio-allantoic membrane inoculation titre
WSE (Type A)	6×10^7	7.6	8
Mel (Type A)	2.5×10^7	7.6	<1
NWS (Type A)	4×10^7	7.1	<1
PR-8 (Type A)	†	7.2	<1
Cam (Type A)	3×10^7	7.1	<1
Cam + (Type A)†	4×10^6	7.0	7
Lee (Type B)	3.5×10^7	7.4	<1
Mel B (Type B)	5×10^7	7.3	<1

* The titre n of infectious units per ml. is $n = y/yz$, where y plaques are produced by a volume y (in ml.) of a dilution z . For example, in the case of WSE, an average of twelve plaques was observed in a 10^{-7} dilution of the virus. Since 2 ml. of virus was used as the inoculum, the titre will be $12/(2 \times 10^{-7}) = 6 \times 10^7$ units per ml. In lower dilutions practically all the cells were destroyed, with the release of neutral red into the solution.

† In two out of four experiments, one or two plaques only were observed, at each dilution throughout a dilution series ranging from 10^{-2} to 10^{-8} . In the other two experiments, the number of plaques produced by PR-8 virus increased with the concentration of virus.

‡ Cam + is the recombinant strain obtained from the interaction of WSE and Cam viruses (ref. 8).

Elephant Seal Cow and Pup on South African Coast

AN elephant seal cow with new-born pup was found on the remote Bredasdorp coast near Cape Agulhas (Cape Province) by one of us (H. B. D. K.) on October 6, 1953. The cow was suckling her black pup, estimated at three or four days old. Colour photographs were taken of the two animals, which were identified as *Mirounga leonina* Linnaeus.

There is no other record of a female elephant seal on the South African coast. The present one is of additional interest in also reporting the first successful birth of an elephant seal pup on this coast. Elephant seals occasionally come ashore on the Cape coast, and have been seen on fur seal islands as far north as Luderitz Bay, South-West Africa. Recent reports are: Cape Peninsula, March, May 1949

February 1950; Knysna, January 1953. The animals were all males.

After the breeding season, male elephant seals leave the rookeries for about two months, before returning again for their annual post-nuptial moult. The whole herd disappears for the winter to lead a pelagic life, presumably near the pack ice of the Antarctic¹. Solitary individuals (stragglers) dispersing to warmer waters in the north pose a peculiar problem of distribution. No elephant seals have resorted in numbers to the South African coast within historical times. The nearest rookeries are Prince Edward Islands (900 miles south-south-east) and the Tristan da Cunha group (1,500 miles west). It would appear that the elephant seals are capable of ranging considerable distances. The present record of a cow successfully giving birth nearly a thousand miles from extant herds is perhaps some evidence of the mechanism of dispersal of breeding populations, at present little understood among the pinnipeds.

H. B. D. KETTLEWELL

Genetics Laboratory,
Department of Zoology,
University of Oxford.

B. RAND

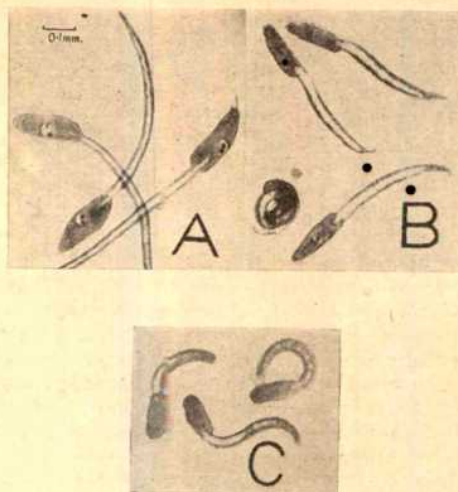
University of Cape Town.

¹ Laws, R. M., Falkland Islands Dependencies Survey, Sci. Rep. 8 (1953).

Production of Abnormal Metamorphosis in a Tunicate

In this laboratory control hatchlings of 95 per cent normal control tadpoles are regularly obtained from cross-fertilized eggs of *Ciona intestinalis*. The addition of phenylthiourea to the sea water in which they are developing produces a characteristic abnormality, which has been obtained regularly. A concentration of 0.001 per cent is effective, but not 0.0001 per cent. Apart from the interference with melanization of sensory vesicle structures, which is known in vertebrates¹, this drug prevents the normal elongation of the notochord. Such tadpoles have short curved tails and do not swim. They remain unchanged after hatching for up to five days, when some attempt metamorphosis, which may be successful in the lower concentrations. Control tadpoles are usually 100 per cent attached and metamorphosing 24 hr. after hatching. When the monsters are placed in normal sea water on hatching, they remain unchanged except for melanization of the sensory vesicle. If, however, they are placed in 0.2 per cent phenylalanine in sea water, the tails are absorbed in 24 hr.; dihydroxyphenylalanine, thyroxine and tyrosine are less effective, approximately in that order. Glycine and alanine do not have this action.

The partial overcoming of the block in metamorphosis by phenylalanine suggested using it together with phenylthiourea. Eggs developing in solutions of 0.05–0.1 per cent phenylthiourea with 0.05–0.2 per cent phenylalanine produced a new monster with greatly retarded head development. In some cases the sensory vesicle is suppressed. As phenylthiourea is an antithyroid drug, another—2-thiouracil—was investigated. Animals developing in from saturated to one-tenth saturated solutions hatched to normal tadpoles, though metamorphosis was retarded up to twelve days and was irregular. The chief effect was a retardation of tail absorption.



A, Normal control tadpoles of *Ciona intestinalis*. B, Tadpoles which have developed in 0.01 per cent phenylthiourea. C, Tadpoles which have developed in phenylalanine and phenylthiourea

It seems that the phenylthiourea monster is not primarily due to an i-thyroid effects.

This work is being continued. Possible antagonists to phenylalanine are being investigated, as is also the influence of the composition of the sea water on the response to the drugs. The pH of the solutions used has varied from 7.6 to 8.2, and normal development occurs in this range in the absence of drugs.

It is easy to obtain many abnormal forms by overcrowding and using dirty glassware, but the phenylthiourea tadpoles are obtained under conditions which give perfect control tadpoles in the absence of the drug.

L. G. E. BELL

Department of Zoology,
King's College,
London, W.C.2
Jan. 31.

¹ Millott, N., and Lynn, W. E., *Quart. J. Micro. Sci.*, 95 (1), 17 (1954).

Chromaffin Tissue in the Lizard Adrenal Gland

BOTH adrenaline and its possible precursor noradrenaline can be obtained from the adrenals of many animals in the different classes of vertebrates¹. In the dogfish, where adrenocortical and chromaffin tissue are entirely separate, the latter contains wholly noradrenaline². In the Amphibia, where the two tissues are intermingled, noradrenaline forms 50–69 per cent of the total catechol content in the frog² and 35–58 per cent in the toad³. In the eutherian mammal, chromaffin tissue, formed as a medulla surrounded by cortical tissue, produces mostly adrenaline^{1,2,4}.

In this laboratory, where the comparative anatomy and physiology of the vertebrate adrenal is being investigated, it has been found that the chromaffin tissue of the lizard adrenal gland (*Lacerta viridis* Laur.) is distributed in a particularly interesting way. The chromaffin cells form two groups of tissue, one embracing the cortex and thickened considerably in the dorsal region of the gland—the peripheral layer—and the other forming 'tongues' and islets intermingling with the cortical cells themselves (Fig. 1).

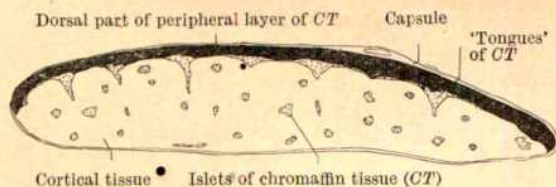


Fig. 1. A diagram of a sagittal section of the lizard adrenal gland showing the distribution of the two types of chromaffin tissue: CT, chromaffin tissue—peripheral layer black tongues and islets stippled

The two groups can be differentiated: (i) by using Hillarp and Hökfelt's iodination method¹, when the peripheral layer of chromaffin tissue acquires a deep brown granular appearance and the tongues and islets a non-granular fawn colour; deep brown pigment formation after iodination is indicative of noradrenaline, adrenaline not reacting in this way¹; (ii) by staining sections, after fixation in Zenker-formol, with Ehrlich's haematoxylin and eosin, when the peripheral layer has a clear yellow colour and the islets and tongues become brownish-purple. Zenker-formol or 2.5 per cent potassium dichromate with adrenaline *in vitro* produces a deep brown colour and ultimately a precipitate, but with noradrenaline a light brown colour and no precipitate results. This may be due to the fact that adrenaline in solution is oxidized more rapidly than noradrenaline².

It is probable, then, that the peripheral layer of the chromaffin tissue in the lizard adrenal secretes noradrenaline, whereas the tongues and islets secrete adrenaline. It seems that the cytoplasm of adrenaline-producing cells has a basophilic property brought out by treatment with Ehrlich's haematoxylin, and that this is not the case with the noradrenaline-producing cell, the cytoplasm of which is unaffected by haematoxylin.

The distribution of chromaffin tissue in the adrenal of the lizard supports the view that adrenocortical cells must be contiguous to influence the formation of adrenaline, perhaps by methylation of noradrenaline³. Presumably this transformation demands adrenocortical steroids in high local concentrations which can only be obtained by the close juxtaposition of chromaffin and cortical tissue. The fowl adrenal is exceptional in that, despite the close intermingling of cortical and chromaffin tissue, it contains 70–80 per cent noradrenaline⁴, and we have found, using histological methods, a similar predominance of noradrenaline in the pigeon adrenal. This is difficult to explain, though it may be possible that variations in the availability of ascorbic acid is one of the essential factors involved.

Certainly the general pattern of change of adrenal form throughout the vertebrates is one of increasing association of cortical and chromaffin tissue, coupled with a changing proportion of noradrenaline to adrenaline. It will be interesting to discover if this variation in proportion is of physiological significance in the different classes of vertebrates.

A. WRIGHT
I. CHESTER JONES

Department of Zoology,
University of Liverpool.
Feb. 7.

¹ Hillarp, N. Å., and Hökfelt, B., *Acta Physiol. Scand.*, **30**, 55 (1954).

² Coupland, R. E., *J. Endocrinol.*, **9**, 194 (1953).

³ Housay, B. A., Gerschman, R., and Rapela, C. E., *Rev. Soc. Argent. Biol.*, **28**, 29 (1950).

⁴ Eränkö, O., *Nature*, **175**, 88 (1955).

⁵ Euler, U. S. v., and Hamberg, U., *Acta Physiol. Scand.*, **19**, 74 (1949).

⁶ Shepherd, D. M., and West, G. B., *Brit. J. Pharmacol.*, **6**, 665 (1951).

Emergence of the Sporoplasm in *Nosema helminthorum*

THE mode of emergence of the infective sporoplasm from Microsporidian spores has baffled protozoologists for many years. According to earlier workers, the sporoplasm creeps out through the aperture from which the filament is extruded. Korke¹, Ohshima², Trager³ and Gibbs⁴ have described a protoplasmic globule at the tip of the extruded filament of the species studied by them. Ohshima and Gibbs thought that the filament pierces through the tissues, 'injecting' the sporoplasm into the host cell; filament extrusion, according to them, being either in a jack-in-the-box manner² or by eversion like the nematocyst of a coelenterate⁴. As Kudo⁵ has remarked, these views ignore the delicate nature of the filament and the fact that the force required to inject the sporoplasm through a long tubular filament would injure it.

I have made some observations on *Nosema helminthorum* Moniez, 1887, which shed light on this problem and indicate the likely arrangement of structures within the mature spore. Spores from infected segments of *Moniezia expansa* left overnight in the refrigerator were examined in a drop of water covered with a cover-slip and lightly pressed. Several spores showed extruded filaments with globular masses attached to their tips; the corresponding spores were completely empty. This preparation was soon dry-fixed after gently removing the cover-slip, and stained in Giemsa stain. The resulting preparation showed more than twenty spores with extruded filaments having an irregular flattened mass at their tips (Fig. 1). These masses of protoplasm, which undoubtedly were the sporoplasms, were seen to be continuations of the filaments and each had a single nucleus also of irregular outline.

From these observations I conclude that the sporoplasm is normally attached to, and is probably a continuation of, the polar filament, which is not hollow. It would seem that inside the spore the coiled filament is surrounded by the sporoplasm in a girdle-like fashion. When the filament is extruded, it is 'whipped out' through a weak place in the anterior end of the spore in a 'jack-in-the-box' manner. The sporoplasm, being a continuation of the filament, is dragged out with it. In some spores, extrusion is so rapid that the sporoplasm is left behind at the aperture of the spore; in other instances the sporoplasm breaks away from the tip of the filament after complete extrusion. This would explain the observations of earlier workers, who appear to have seen the sporoplasm at the aperture, and also the fact that in most instances the extruded filament

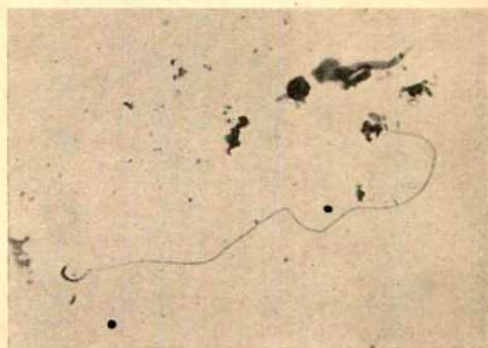


Fig. 1. Photomicrograph of a spore of *Nosema helminthorum*, showing sporoplasm at the tip of extruded filament. ($\times 700$)

does not show any structure at its tip although the spore is completely empty. Finally, I do not think that a polar capsule exists in the spores, nor do I believe that such a delicate structure as the polar filament can penetrate the thick cuticle of *Moniezia*. I suggest that all it does is to help apply the very fluid sporoplasm to the host tissue, and that thereafter the sporoplasm works its way in by secreting a histolytic substance.

A. S. DISSANAIKE

Department of Parasitology,
London School of Hygiene and Tropical Medicine,
London, W.C.1.

Feb. 4.

¹ Korke, V. T., *Ind. J. Med. Res.*, 3, 725 (1916).

² Ohshima, K., *Annot. Zool. Jap.*, 11, 235 (1927); *Parasit.*, 29, 220 (1937).

³ Trager, W., *J. Parasit.*, 23, 226 (1937).

⁴ Gibbs, A. J., *Parasit.*, 43, 143 (1953).

⁵ Kudo, R. R., *Illinois Biol. Monographs*, 20, 7 (1944).

Uses of the Globe Photometer

ONE may measure the vertical component of daylight in any site by exposing a photometer with a plane perfectly diffusing surface set horizontally. For certain purposes one may set the photometer so as to receive the maximum illumination possible. These illuminations may be expressed as percentages of the diffuse light of the whole sky. Much attention has been given to such determinations in the design of modern buildings.

We measured these daylight factors about twenty-five years ago when studying plant growth in woodlands, illumination in houses and in the sea. For this work vacuum photo-cells were used, also solutions of uranium oxalate in tubes or flasks. The flask¹ gives a better measure of the illumination as it affects plant growth, since it receives light from all angles as a bush does, and it is equally sensitive to sunlight at any angle.

Later² we described a globe photometer in which a selenium rectifier cell—a disk—was mounted horizontally under the usual opal-flashed glass plate but covered with both an opal hemisphere and an opal globe, so as to render the disk equally sensitive to sunlight at any angle.

Using two such globes, one can determine the illumination at a shaded point expressed as a percentage of the total diffuse light in the open, namely, I/I_{sky} , as against V/V_{sky} . The former gives a more satisfactory expression for the general lighting of a room, direct and indirect, especially as to plant growth. With the selenium cells low-resistance galvanometers must be used and the form of the current/illumination curve must be determined.

More recently, we have assembled a globe photometer with a thin-film cesium-on-silver-oxide vacuum photo cell, a type which had proved constant in sensitivity when exposed for more than three years on a roof. This is free from temperature error and always gives a rectilinear relation between current and illumination. It is thus suitable for use in recording daylight over a long period.

W. R. G. ATKINS
H. H. POOLE

Royal Dublin Society.
Jan. 20.

¹ Atkins, W. R. G., and Poole, H. H., *Sci. Proc. Roy. Dublin Soc.*, 19 (19), 173 (1929).

² Atkins, W. R. G., and Poole, H. H., *Phil. Trans. Roy. Soc., A*, 235 (752), 245 (1936).

Rotational Analysis of the Tantalum Oxide Bands

THE bands of tantalum oxide have been photographed in the second order of a 21-ft. concave grating having 30,000 lines per inch and giving a dispersion of 0.6 Å./mm. Rotational structure of three of these bands, λ 3,747 (ν 26,679), λ 4,155 (ν 24,063) and λ 4,232 (ν 23,348), has been analysed; the first of these is the (0,0) head of one system and the other two are the (1,0) and (0,0) heads of another system of TaO^1 . The analysis indicates that (1) the three bands have a common Σ ground-state which is probably a doublet, (2) ν 26,679 results from a transition between two doublet Σ states, and (3) ν 23,348 and ν 24,063 are attributed to the transition $^3\Pi - ^2\Sigma$.

The following constants have been determined for the different states involved in the emission of these bands:

Ground state Σ	Excited state Σ	Excited state $^3\Pi_{3,2}$
$B_0 = 0.3434 \text{ cm.}^{-1}$	$\bar{B}_0 = 0.3205 \text{ cm.}^{-1}$	$B_0 = 0.3178 \text{ cm.}^{-1}$
$I_0 = 81.51 \times 10^{-40} \text{ gm. cm.}^2$	$\bar{I}_0 = 87.94 \times 10^{-40} \text{ gm. cm.}^2$	$B_0 = 0.3156 \text{ cm.}^{-1}$
$r_0 = 1.827 \times 10^{-6} \text{ cm.}$	$\bar{r}_0 = 1.891 \times 10^{-6} \text{ cm.}$	$B_1 = 0.3112 \text{ cm.}^{-1}$
		$\bar{a} = 0.0044 \text{ cm.}^{-1}$
		$I_0 = 88.06 \times 10^{-40} \text{ gm. cm.}^2$
		$r_0 = 1.900 \times 10^{-6} \text{ cm.}$

The D values in all cases are of the order of 10^{-6} cm. A study of the Λ type doubling in the two bands ν 23,348 and ν 24,063 indicates that the $^3\Pi$ -state belongs to a near case (a) of coupling and is probably inverted. Details of this work will be published elsewhere.

D. PREMASWARUP

Physics Department,
Andhra University,
Waltair.
Jan. 8.

¹ Premaswarup, D., *Ind. J. Phys.* (in the press).

Origin and Age of Meteorites

IN his recent article under this title¹, Prof. H. C. Urey says: "While the excellent studies of Paneth and his co-workers are most interesting because of the facts which they present about the formation of meteorites and the effects of cosmic rays, I believe that it is very difficult to decide what event or events were recorded by the helium, uranium and thorium abundances".

We should like to put on record that we agree with Prof. Urey that there are difficulties in the interpretation of our results; but that we do not think that his statements prove that our arguments, leading to an age of no more than a few hundred million years, are incorrect. We are not convinced that his interesting thermodynamic reasoning can be applied to the calculation of the maximum quantities of uranium and thorium in iron meteorites, since it is by no means certain that their distribution was achieved under equilibrium conditions.

Prof. Urey conjectures that the uranium and thorium are present only in silicate and sulphide inclusions, and that the helium has leaked from these inclusions along fissures. While it is true that some meteoritic irons do contain substantial inclusions and fissures, we should like to direct attention to the fact that the beautifully homogeneous Savik iron (in which

the uranium was determined, with concordant results, by four different methods) has no visible inclusions. The total volume provided by fissures would be so small that it would be necessary to assume in them a concentration of uranium far greater than is, in fact, found in silicates or sulphides of meteoritic origin.

A definite test whether or not the radioactive material is concentrated along fissures could be obtained by photographic methods which, however, are difficult in this case owing to the very low activities. We are much indebted to Dr. E. Picciotto, of the Laboratoire de Physique Nucléaire at Brussels, for privately showing us preliminary results obtained by him and Mrs. Deutsch with a slice of the Carbo meteorite; these do not seem to us to lend any support to Prof. Urey's hypothesis; but Dr. Picciotto hopes to increase the accuracy, and his final results will be awaited with great interest.

In the last paragraph but one of his article, Prof. Urey refers in four or five consecutive sentences to as many possibilities for the origin and age of meteorites. We would like to suggest that our views should be added as one more possibility.

F. A. PANETH

Max-Planck-Institut für Chemie,
Mainz.

G. R. MARTIN

S. J. THOMSON

Londonderry Laboratory for Radiochemistry,
University of Durham.

¹ *Nature*, 175, 321 (1955).

"Applied Statistics"

IN his review of my book "Statistical Methods in Electrical Engineering" (*Nature*, March 19, p. 484), Mr. F. Downton criticizes my statement that Bayes' theorem is controversial. The heading of the paragraph in Sir Ronald Fisher's book which I cited is "The Rejection of Inverse Probability". Coupled with the lack of mention of Bayes beyond the introductory chapter, I can only take this to mean that the author did not accept the rigorous validity of anything which Bayes formulated. To me, therefore, it appears that Mr. Downton's statement is demonstrably untrue. Faced with this controversial issue when writing a practical book, I decided to mention the existence of the controversy and then take a firm decision (the opposite of Fisher's) which was justified primarily on empirical grounds.

The question of $\sqrt{(N-1)}$ depends on a distinction between (a) the dispersion of a group of observations and (b) the probable difference between the mean of the group and a determinate true value.

If my book should survive the disfavour of statisticians and reach a second edition, I will bear in mind Mr. Downton's suggestion that congestion theory should be mentioned, though I should not attempt to satisfy his desire for a "definitive" treatment of this subject.

D. A. BELL

Electrical Engineering Department,
University of Birmingham.

THE position with regard to Bayes' theorem is admirably set out in M. G. Kendall's "The Advanced Theory of Statistics", Vol. 1, pp. 175-176 (3rd edit., 1947), where my statement that it is the assumptions and not the theorem which are controversial is sup-

ported. Reconciliation of the quotations from Fisher, Jeffreys and my review, which Dr. Bell finds contradictory, depends on the recognition that the terms 'postulate', 'axiom' and 'theorem' are not synonymous.

The extract from Dr. Bell's book, which I quoted in my review, makes it quite clear that he stated, erroneously, that the standard deviation of the mean of N observations varies inversely as $\sqrt{N-1}$ (that is, presumably, case (b) above); for the correct expression see any elementary text-book; for example, C. E. Weatherburn, "A First Course in Mathematical Statistics", p. 185 (1946). It is to be hoped that this correspondence will not give readers the impression that these are matters which are likely to cause disagreement among statisticians.

F. DOWNTON

Department of Applied Mathematics,
University of Liverpool.

An Amplifier based on the Hall Effect

THE achievement of a Hall effect amplifier by Ross and Thompson, as recorded in *Nature* of March 19, p. 518, is quite remarkable, even taking into consideration the very high carrier mobility obtainable with indium antimonide. Calculation shows that a power gain is only possible if every effort is made to get the required magnetic field with the minimum power input, and this clearly entails the use of a high permeability core with a very thin crystal in a correspondingly small air-gap. The power gain is derived from the input of current to the crystal, and theoretically there appears to be no limit to the amplification obtainable if it were possible to raise the strength of the magnetic field indefinitely. In practice, saturation must occur. By the same argument an input signal applied to the current terminals of the crystal when immersed in a steady magnetic field could not lead to amplification. There is then no independent source of power input, and in this case the usual expression for the Hall output cannot therefore remain valid with large signals. The amplifier of Ross and Thompson seems to be limited to low-frequency applications unless a semi-conductor of still higher carrier mobility becomes available.

It should be possible to make the amplifier into an oscillator by feeding back the output from the Hall terminals to the magnetizing coil.

H. M. BARLOW

University College,
London, W.C.1.

WE agree with Prof. Barlow that considerable refinement in technique is required to achieve gain. In addition to those points which he mentions as essential, it is necessary also to have very good thermal contact between the crystal and the magnetic core, in order that a high input current density may be used without appreciable heating of the crystal. Although only small power gains have so far been achieved, we think that the device is capable of considerable development.

I. M. ROSS

N. A. C. THOMPSON

Services Electronics Research Laboratory,
Baldock, Herts.

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, June 6

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. G. Hattersley-Smith. "Ellesmere Land".

Tuesday, June 7

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. B. Ephrussi. "Intrinsic Factors Controlling the Synthesis of Cytochromes in Yeast" (Aunroth Wright Lecture).

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. G. A. Barnard. "Technometrics and the Mathematical Needs of Modern Technology" (Inaugural Lecture).

Tuesday, June 7—Saturday, June 11

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Grand Hotel, Llandudno)—Conference on "Film Structure and Adhesion".

Wednesday, June 8

GEOLOGICAL SOCIETY OF LONDON (at Burlington House Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Thursday, June 9

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "Radiative Balance in the Atmosphere", opened by Prof. H. S. W. Massey, F.R.S.

BRITISH SOCIETY FOR RESEARCH IN AGEING (at the Ciba Foundation, 41 Portland Place, London, W.1), at 2 p.m.—Symposium on "Endocrinology and Ageing".

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 4.45 p.m.—Mr. W. Muckle: "The Influence of Dimensions on the Behaviour of Partial Superstructure"; Mr. J. B. Caldwell: "The Strength of Corrugated Plating for Ships' Bulkheads".

BONE AND TOOTH SOCIETY (at the Institute of Orthopaedics, 234 Great Portland Street, London, W.1), at 5 p.m.—Annual General Meeting, followed by "Casual Communications".

MEN OF THE TREES (at Chelsea Physic Garden, Swan Walk, London, S.W.3), at 5 p.m.—Annual General Meeting. Mr. N. W. Pirie, F.R.S.: "New Ways with Trees".

MINERALOGICAL SOCIETY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Friday, June 10

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. O. Kraymer (Harvard Medical School): "New Aspects of the Pharmacology of Veratrum Alkaloids—The Anti-accelerator Cardiac Action of the Secondary Amines".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Graham Sutton, F.R.S.: "Weather Forecasting—The Future Outlook".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

—PHYSICIST (honours graduate) in the Physics Department, mainly for work connected with radiotherapy by X-ray and gamma-rays (including a 1,000-curie radiocobalt and a 4 million volt linear accelerator)—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middlesex (June 10).

ASSISTANT, Grade B (with graduate or equivalent qualifications, and preferably with teaching, industrial or research experience) in CHEMISTRY—The Registrar, The Technical College, Sunderland (June 11).

ASSISTANT LECTURER IN PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (June 11).

DEMONSTRATORS IN THE SCHOOL OF CHEMISTRY—The Registrar, The University, Leeds 2 (June 11).

LECTURER IN GREEK ARCHAEOLOGY AND ANCIENT HISTORY—The Registrar, King's College, Newcastle-upon-Tyne (June 11).

RESEARCH ASSISTANTS (preferably graduates with some experience of single-crystal X-ray diffraction methods) in THE CRYSTALLOGRAPHIC SECTION of the Cavendish Laboratory for the structure analysis of organic crystals, minerals and alloys—The Secretary of the Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (June 11).

DEMONSTRATOR (with a good honours degree in physiology, biochemistry, or chemistry, with subsidiary physiology, or medically qualified) in CHEMICAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (June 13).

LECTURER, Grade II, and an ASSISTANT LECTURER, Grade III, or a RESEARCH FELLOW, in THE DEPARTMENT OF THEORETICAL MECHANICS, Faculty of Engineering—The Registrar, The University, Bristol (June 13).

JUNIOR LECTURER IN MATHEMATICS—J. S. de Wet, Balliol College, Oxford (June 17).

• ASSISTANT LECTURER (preferably with a medical qualification) in THE DEPARTMENT OF PHARMACOLOGY—The Welsh National School of Medicine (University of Wales), 34 Newport Road, Cardiff (June 18).

LECTURER IN METALLURGY—The Registrar, The University, Sheffield (June 18).

LECTURER or ASSISTANT LECTURER (with special interests in physico-organic chemistry) in CHEMISTRY—The Secretary, University College, Exeter (June 18).

RESEARCH ASSISTANT (graduate, with previous experience in the field of natural product chemistry, preferably in isolation and degradative studies on alkaloids) in THE DEPARTMENT OF CHEMISTRY, University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 23).

RESEARCH OFFICER (with a university honours degree in science with organic chemistry as a major subject, and knowledge and experience in the use of modern techniques of isolation and separation) in THE ORGANIC CHEMISTRY SECTION, Alkaloids Subsection, Commonwealth Scientific and Industrial Research Organization, Fishermen's Bend, Melbourne, Australia, to carry out investigations on the chemistry of substances given out by plant roots—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 590/551 (June 24).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with broad scientific interests and a university honours degree or equivalent in science, and preferably with research experience) in THE DIVISION OF BUILDING, Commonwealth Scientific and Industrial Research Organization, Highett (near Melbourne), to undertake research both basic and applied, on fibrous plaster—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 390/217 (June 24).

TECHNICAL SECRETARY (with a university honours degree in science, with chemistry or fuel technology as a major subject or equivalent qualifications, and with research and/or industrial experience in fuel technology) in THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, N.S.W., Australia, to assist the Officer-in-Charge in the administration and initiation of research concerned with the properties and utilization of Australian coals—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/104 (June 24).

SENIOR LECTURER, a LECTURER, and an ASSISTANT LECTURER in THE DEPARTMENT OF PHYSICS, to work or carry out research in one or more of the following fields: nuclear physics, theoretical physics and radio-astronomy—The Registrar, The University, Manchester 13 (June 25).

CHAIR OF AERONAUTICS—The Secretary, Queen's University, Belfast (June 29).

ASSISTANT LECTURER (with an honours degree in agriculture or agricultural economics, or equivalent qualifications) in AGRICULTURE with special reference to Farm Management and Work Husbandry—The Registrar, The University, Reading (June 30).

CHAIR OF MATHEMATICS (Pure and Applied), and a SENIOR LECTURER in PHILOSOPHY at the University of Natal, Durban, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 30).

SENIOR LECTURER in PHYSICS at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 30).

LECTURER in EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (July 6).

ASSISTANT LECTURER in PHILOSOPHY—The Registrar, University College of North Staffordshire, Keele, Staffs (July 7).

PHYSICIST (preferably well versed in radiological physics and some knowledge of isotope counting techniques) in THE RADIOTHERAPY DEPARTMENT—Dr. C. M. Bethune, Superintendent, Victoria General Hospital, Halifax, Nova Scotia, Canada (July 15).

ASSISTANT LECTURER, Grade B, in THE DEPARTMENT OF CHEMISTRY AND APPLIED CHEMISTRY—The Principal, Royal Technical College, Salford 5.

ASSISTANT LECTURER (graduate in chemistry or biochemistry, and preferably with experience in the food industry)—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

ASSISTANT LECTURER (with a good honours degree of a British university) to assist with teaching physics to the level of the B.Sc. special degree—The Registrar, Medway College of Technology, Maidstone Road, Chatham.

ASSISTANT STATISTICIAN, Assistant Experimental Officer or Experimental Officer grade (with a degree in mathematics, or economics with statistics, or equivalent qualifications) in THE DEPARTMENT OF STATISTICS, Agricultural Research Statistical Service—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

EXPERIMENTAL OFFICER (graduate in agriculture or agricultural chemistry) in THE CHEMISTRY DEPARTMENT, to assist with field experiments on fertilizers and on soil fertility problems—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "160".

INDEPENDENT FORECASTER (with a university degree in physics or mathematics, and experience of independent forecasting and general work of a city meteorological office, forecasting for the general public and shipping, investigation of meteorological problems, routine climatological returns, and checking work of assistant staff) in THE METEOROLOGICAL DEPARTMENT, Government of Bermuda, Bermuda—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.57/29/01.

LECTURER in PHYSICAL METALLURGY—The Registrar, The University, Edgbaston, Birmingham 15.

LECTURER in RUBBER TECHNOLOGY—National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

LECTURER or ASSISTANT LECTURER (with special qualifications in organic chemistry) in PHARMACEUTICAL CHEMISTRY—The Registrar, The University, Nottingham.

LECTURER (with previous teaching experience and preferably industrial experience) in PHYSICAL CHEMISTRY, to teach to special B.Sc. standard—The Principal, West Ham College of Technology, Romford Road, Stratford, London, E.15.

NUTRITIONAL CHEMIST (with an honours degree in chemistry or Associate of the Royal Institute of Chemistry) in THE DEPARTMENT OF VETERINARY SERVICES AND ANIMAL HUSBANDRY, Uganda, to investigate the nutritional value of local foodstuffs and to undertake metabolism studies of indigenous farm livestock—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.67/0/09.

PHYSICIST, Senior Scientific Officer grade (with a first- or second-class honours degree or equivalent in physics, and at least three years postgraduate research experience of electronic measurement), at the Royal Aircraft Establishment, Farnborough, Hants, to undertake responsibility for instrumentation of supersonic wind tunnels, a hyper-sonic tunnel and a shock tube, and development of techniques for measurement and recording—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.169/5A.

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry or chemical engineering, and several years experience in chemical engineering practice as applied to research and development, and in pilot plant studies), to lead a team concerned with the development of a new chemical plant—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 561/WG/2.

READER or LECTURER in CLASSICAL ARCHEOLOGY—The Secretary of Faculties, University Registry, Oxford.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in chemistry or Associateship of the Royal Institute of Chemistry, or equivalent qualifications), for research and development work in analytical chemistry with particular reference to the provision of analytical methods for the control of processes in the manufacture of some less common elements—The Works Secretary, United Kingdom Atomic Energy Authority, Springfields Works, Salwick, Preston, quoting Ref. 047.

SENIOR LECTURER, LECTURER or ASSISTANT LECTURER in PHYSICS, at the University College of Khartoum—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Forestry Institute, University of Oxford. Thirtieth Annual Report, 1953-54. Pp. 29. (Oxford: Imperial Forestry Institute, University of Oxford, 1955.) [313]

The Manchester Museum, The University, Manchester. Report of the Committee for the year ending July 31st, 1954. Pp. 24. (Manchester: The University, 1955.) [313]

Industrial Diamond Information Bureau. The Diamond Tool Industry in 1954. Pp. 12 (London: Industrial Diamond Information Bureau, 1955.) [313]

Library Association. Year Book, 1955. Pp. lxviii+126+List of Members and Professional Register. 21s. (15s. to L.A. members). Library Association Pamphlet No. 12: Subject Specialisation and Co-operative Book Purchase in the Libraries of Great Britain. By K. G. Hunt. Pp. 32. (London: Library Association, 1955.) [54]

Sir John Cass College. Report—Session 1953-54. Pp. 21. (London: Sir John Cass College, 1955.) [54]

Forestry Commission. Bulletin No. 24. The Volume-Basal Area Line: a Study in Forest Mensuration. By Dr. F. C. Hummel. Pp. iv+84. 9s. net. Leaflet No. 8: Megastigmus Flies Attacking Conifer Seed. Pp. 10. 6d. net. (London: H.M. Stationery Office, 1955.) [54]

Geography as a Humane Study. By Prof. E. W. Gilbert. (An Inaugural Lecture delivered before the University of Oxford on 12 November 1954.) Pp. 23. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 2s. 6d. net [54]

Carnegie United Kingdom Trust. Family Diet and Health in Pre-War Britain: a Dietary and Clinical Survey. (Report to the Carnegie United Kingdom Trust from the Rowett Research Institute) Pp. 164. (Dunfermline: Carnegie United Kingdom Trust, 1955.) [54]

University of Leeds. Annual Report of the Librarian, Session 1953-54. Pp. 11. (Leeds: The University, 1954.) [54]

Radio Isotope Instrumentation and Accessories. Pp. 124. (London: Scientific Instrument Manufacturers Association of Great Britain, Ltd., 1955.) [54]

Journal of Inorganic and Nuclear Chemistry. Vol. 1, Nos. 1/2 (March 1955). Pp. 164. Subscription per volume (8 numbers) (A) 90s.; 12 60 dollars. Rate (B) for individual subscribers certifying that the journal is for their private use 70s.; 9 80 dollars. (London and New York: Pergamon Press, Ltd., 1955.) [54]

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 18, No. 4. Echo Sounding Experiments on Fish. By D. H. Cushing and I. D. Richardson. Pp. ii+34+1 plate. (London: H.M. Stationery Office, 1955.) 5s. 6d. net [54]

Electrical Research Association. Technical Report Z/T84: The Pre-Nova Stage of a Star. By C. E. R. Bruce. Pp. 9. 6s. Technical Report L/T303: Growing of Perovskite-Type Crystals. By H. P. Kay and J. L. Miles. Pp. 11+1 figure. 7s. 6d. Technical Report L/T310 Breakdown of Solid Dielectrics in Divergent Fields. By J. H. Mason. Pp. 24+figures 1-16. 21s. (Leatherhead: British Electrical and Allied Industries Research Association, 1952 and 1954.) [54]

Observations made at the Royal Observatory, Greenwich, in the year 1940 in Astronomy, Magnetism and Meteorology, under the direction of Sir H. Spencer Jones. Pp. viii+342. (London: H.M. Stationery Office, 1953.) 30s. net. [54]

1955 Farm Holiday Guide. Edited by D. Murdoch. Pp. iii+112+24 plates. (Paisley: Farm Holiday Guides, 18 High Street, 1955.) [124]

Other Countries

United States Department of Agriculture. Technical Bulletin No. 1107 Ecological Studies on the Potato Psyllid as a Pest of Potatoes. By R. L. Wallis. Pp. 24. (Washington, D.C.: Government Printing Office, 1955.) 15 cents. [313]

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 38, No. 2. Most Accidents Occur Off the Job. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [313]

Bulletin of the American Museum of Natural History. Vol. 105, Article 4: Studies of Nearctic *Coenonympha tullia* (Rhopalocera, Satyridae)—*Coenonympha tullia inornata* Edwards. By F. Martin Brown. Pp. 359-410+plates 28 and 29. 75 cents. Vol. 105, Article 5: The Phenacoleuridae, New Family of Early Primates. By George Gaylord Simpson. Pp. 411-442+plates 30-35. 75 cents. (New York: American Museum of Natural History, 1955.) [313]

Institut de France. Académie des Sciences. Annuaire pour 1955. Pp. 215. Index Biographique des Membres et Correspondants de l'Académie des Sciences, du 22 Décembre 1666 au 15 Novembre 1954. Pp. xi+534. (Paris: Gauthier-Villars, 1955.) [54]

United States Department of Agriculture. Circular No. 952 (December 1954): Flavor and Benzene Hexachloride Content of Peanuts Grown in Rotation with Cotton Dusted with Insecticides Containing Benzene Hexachloride. By Howard Reynolds and Gladys L. Gilpin. Pp. 26. (Washington, D.C.: Government Printing Office, 1954.) 15 cents. [54]

Annales de l'Institut Phytopathologique Benaki. Année 8, Fascicule 1: Rapport sur les Travaux Expérimentaux de Lutte Contre le Dacus a Rovies (Eubée) pendant l'Année 1953. Par A. J. Ayoutantis, E. D. Peléassis, Mlle. L. Ch. Argyriou, P. A. Mourikis et L. E. Tsacas. Pp. 75+1 plate. (Athènes: Institut Phytopathologique Benaki, 1954.) [54]

Academia Brasileira de Ciências. Principal Results about the Reactivity of Solids. By J. A. Hedvall. (Lecture at the meeting of the Academia Brasileira de Ciências, September 22, 1953.) Pp. i+11. (Rio de Janeiro: Academia Brasileira de Ciências, 1954.) [54]

New Soviet Researches, Explorations and Discoveries in the Central Arctic. (Anon.) Translated from Izv. Akad. Nauk. Ser. Geog. 1954, 5, 3-16, by E. R. Hope, and a New Picture of Magnetic Disturbance in the High Latitudes (Translator's Comments) Pp. 40. (T 165 R.) (Ottawa: Defence Scientific Information Service, Defence Research Board, 1954.) [124]

La Imagen del Universo Físico y la Entropía. By Augusto Böttig. Pp. 21. (Tucumán: Ministerio de Educación de la Nación; Universidad Nacional de Tucumán.) [124]

United States Department of Agriculture. Leaflet No. 382: The Fowl Tick: How to Control It. (Washington, D.C.: Government Printing Office, 1955.) 5 cents. [124]

Union of South Africa. Department of Mines. Bulletin 22: Bore-Hole Temperature in the Klerksdorp and Orange Free State Areas. By R. F. Bouwer. Pp. ii+35. (Pretoria: Government Printer, 1954.) 3s. [124]

Pasteur Institute of Southern India, Coonoor. Annual Report of the Director, 1953, and Scientific Report, 1954. Pp. 63. (Coonoor, S. India: Pasteur Institute, 1955.) [124]

Publications de l'Institut National Turc de Bibliographie. Bibliographie des Articles Parus dans les Periodiques Turcs 1953: 7-9 (Juillet-Septembre). Pp. 116. (Istanbul: Maarif Basimevi, 1954.) [124]

Annual Report of the Indian Central Jute Committee, for the year 1953-1954. Pp. ii+300. (Calcutta: Indian Central Jute Committee, 1955.) [124]

International Council of Scientific Unions. Joint Commission on Radio-Meteorology. Proceedings of the Third Meeting held in Brussels August 16-18, 1954. Pp. 30. (Brussels: International Scientific Radio Union, 1955.) 25 Belgian francs; 4s. [124]

International Scientific Radio Union. Proceedings of the 11th General Assembly, held in The Hague from August 23rd to September 2nd, 1954. Vol. 10. Part 1, Commission 1: On Radio Measurements and Standards. Pp. 57. (Brussels: International Scientific Radio Union, 1955.) 60 Belgian francs; 8s. 8d. [124]

Consejo Superior de Investigaciones Científicas. Publicaciones del Instituto de Química "Alonso Barba" Vol. 8, Año 1954. Pp. iii+317. (Madrid: Instituto de Química "Alonso Barba", 1954.) [124]

Statistical Information on Component Parts of Chemical Compounds. By Estaleta Dale and Karl F. Heumann. Pp. iii+12. (Washington, D.C.: Chemical-Biological Coordination Center, National Academy of Sciences—National Research Council, 1955.) [124]

Annals of Zoology. Vol. 1, No. 1 (January 31, 1955). Pp. 1-22 (Subscription rate for each volume of approx. 240 pages. 15 rupees., 30s.) (Agra: Academy of Zoology, 164 Civil Lines, 1955.) [124]

Stanford Research Institute. Annual Report for 1954. Pp. 49. (Stanford, Calif.: Stanford Research Institute, 1955.) [124]

Editorial and Publishing Offices of "NATURE"

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8931. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

NATURE

No. 4467

SATURDAY, JUNE 11, 1955

Vol. 175

CONTENTS

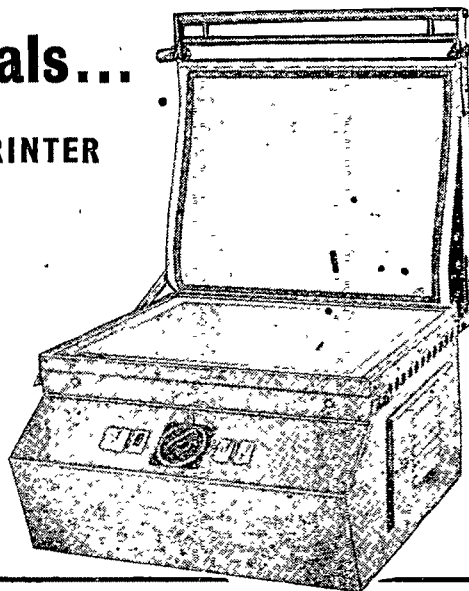
	Page
School, University and Community	1007
English Mathematicians of the Sixteenth and Seventeenth Centuries. By Dr. D. P. J. Vood	1009
Cultivation of Cocoa	1010
The English Climate. By L. C. W. Bonacina	1011
Social Medicine. By Sir Arthur MacNalty, K.C.B.	1011
The 156-in. Cyclotron at Liverpool. By M. J. Moore	1012
Department of Scientific and Industrial Research: Report for 1953-54	1015
Antoine-François de Fourcroy (1755-1809). By W. A. Smeaton	1017
British Astronomers at the Total Solar Eclipse of June 20. By Prof. R. O. Redman, F.R.S.	1018
Obituaries:	
Dr. Otto Rosenheim, F.R.S. By Dr. Harold King, C.B.E., F.R.S.	1019
Dr. R. W. Boyle. By Dr. D. A. Keys	1020
Mr. F. G. Simpson, C.B.E. By Prof. I. A. Richmond	1020
News and Views	1021
New Laboratories for Inorganic and Physical Chemistry in the University of Liverpool	1026
Harwell Meeting of the Physical Society. By W. D. Allen and P. A. Egelstaff	1027
Materials for Radio Valves. By Dr. R. L. Smith-Rose, C.B.E.	1029
Phylogeny of the Basidiomycetes	1030
World Congress of Medical Practitioners for the Study of Present-day Living Conditions	1030
Effect of Thermal Shock on the Nucleic Acids in Toad Embryos during Early Stages of Development. By H. Hasegawa	1031
The Human Intervertebral Disk. By Dr. F. Happey, W. G. Horton, T. P. MacRae and A. Naylor	1032
Letters to the Editors:	
Thermodynamic Data for Myoglobin, Hæmoglobin and Cytochrome-c Reactions, and the Position of the Hæm Groups.—Dr. Philip George and G. I. H. Hanania	1034
Production of Membrane Potential Changes in the Frog's Heart by Inhibitory Nerve Impulses.—Dr. J. del Castillo and Prof. B. Katz, F.R.S.	1035
Development of Fertilizing Capacity of Rabbit Spermatozoa in the Uterus.—Dr. M. C. Chang	1036
Effect of Triethylene Melamine on the Fertility of Rats.—Dr. Harold Jackson and Marion Bock	1037
Polyspermy after Induced Hyperthermia in Rats.—Dr. C. R. Austin	1038
Chromosome Aberrations caused by Radioactive Thymidine.—Henry A. McQuade, Morris Friedkin and Alice A. Atchison	1038
Creatine-Creatinine Metabolism in Radiation Myopathy.—G. L. Haberland, K. Schräier, F. Bruns, Dr. K. I. Altman and L. H. Hempelmann	1039
Protective Action of Monospecific Anti- <i>Brucella</i> Sera in Mice.—Dr. D. Sulitzeanu, L. Jones and A. W. Stableforth	1040
Microbiological Determination of Free Amino-Acids in the Body Fluid of the Silkworm Larva (<i>Bombyx mori</i>). —T. Fukuda, J. Kirimura, M. Matuda and T. Suzuki	1041
Preparation of Metallic Isotopic Targets of the Alkali and Alkaline Earth Metals by Evaporation of their Compounds. —D. H. Randall and Dr. M. L. Smith	1041
Scintillation Techniques for the Detection of Natural Radiocarbon.—B. L. Funt, S. Sobering, Prof. R. W. Pringle and W. Turchinetz	1042
Chemical Effects associated with 'Colour Centres' in Alkali Halides.—Dr. W. G. Burns and T. F. Williams	1043
Structure of Native and Mercerized Celluloses.—C. Legrand, A. Bonnemayre, Dr. A. Guinier and P. Antzenberger	1045
Synthesis of Poly-S-Allylcysteine (Poly-Deoxo-Aliin).—Prof. Max Frankel and Albert Zilkha	1045
Proof of the Heisenberg Relations.—Dr. D. ter Haar and W. M. Nicol	1046
Germination of Rice Embryo under Water and its Relation of Growth to Endosperm Fractions.—Dr. S. M. Sircar, Dr. T. M. Das and A. N. Lahiri	1046
A Mosaic Disease of Leguminous Plants caused by a Strain of Tobacco Mosaic Virus.—R. M. Lister and J. M. Thresh	1047
Normal Mouth and Intestinal Flora of the Ferret (<i>Mustela furo</i> L.).—Dr. M. Elizabeth Davies	1048
Effect of Chloretone on Tunicate Embryos.—Dr. L. G. E. Bell	1048

Copy documents...journals... books WITH THIS NEW, LARGER PRINTER

★ The new 'Duostat' Printer Model 14/18 greatly increases the scope and usefulness of document copying in the laboratory. It will copy single documents up to 14 x 18 ins., pages from technical journals, and books up to 11 x 16 x 1½ ins.

Illumination is even over the whole area and can be varied to suit the materials used. A vacuum blanket ensures perfect contact between the original and the copying paper.

The 'Duostat' Printer adds to photography's accuracy the advantages of speed, convenience and easy control. In its new, larger size it can be used for many copying jobs normally beyond the scope of office copying equipment.



Duostat Printer

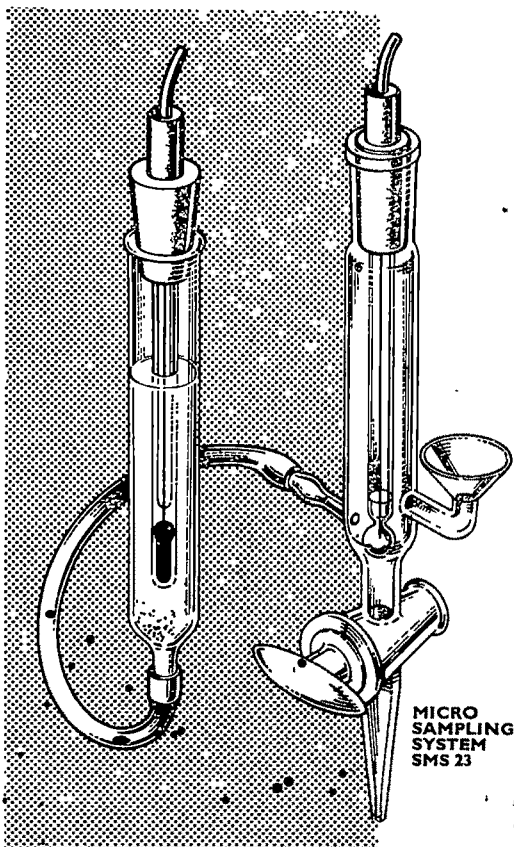
Kodak Ltd., Industrial Sales Division, Kodak House, Kingsway, London, W.C.2.

'Duostat' is a registered trade-mark.

MODEL
14/18

When every dot, symbol and figure of a scientific document has to be reproduced with absolute accuracy, photographic copying is safest. When, in addition, speed and easy control are required, the 'Duostat' Printer is recommended. Details will be sent with pleasure. Please mention "Nature" when writing.

1483



MICRO
SAMPLING
SYSTEM
SMS 23

pH Electrodes

There are more than 50 different types of special pH electrodes in the E.I.L. range. These include electrodes for micro-analysis and micro-titration, a hypodermic pH electrode for clinical use and high temperature and low temperature electrodes for laboratory investigations. Other types can be made to order.

These electrodes are designed for use with the E.I.L. Model 23A Direct Reading pH Meter but can be adapted for most types of pH meters having an equivalent performance.



the pH people

ELECTRONIC INSTRUMENTS LTD
RICHMOND SURREY

SCHOOL, UNIVERSITY, AND COMMUNITY

THE debate on the vote for the Ministry of Education in the House of Commons on April 26 well illustrates the recurrent weakness of many discussions on education in Britain during recent years. Sir David Eccles presented the estimates with his customary imaginative awareness of the real issues, and, at least for a moment when he discussed the relation of primary and secondary education to the demand for skilled man-power at all levels and the possibilities of raising educational standards, he lifted the debate out of the commonplace. He was confident that the total number of school places would soon draw ahead of the number of school children: in spite of a 30 per cent increase in the school population, the size of classes has risen, he said, by only 3 per cent. In the next five years the numbers of infants and juniors would fall by 400,000, and seniors would increase by 600,000, and last year new school places increased by that net figure.

The core of the general problem, as of some of the particular problems, is the number, and also the quality, of teachers, and here too Sir David was optimistic. Confidence, he claimed, is returning to the teaching profession. Only this, he believes, can explain the great rush for places in the training colleges, for which by April 1, 1955, there were 1,500 more applicants than in 1954, and 2,500 than at the same date in 1953. That is a factor which should assist both the maintenance of professional standards and the reduction in the size of classes, which should now be possible. Even if the substantial increase in the number of new places under construction in the current building programme fails to materialize, he said, there will still be a million new school places available in the next five years against the predicted net increase of 200,000 in the population.

Sir David did not discuss in any detail the alternatives now opened up in the way of improving standards, though he indicated that we should consider whether it is desirable to go further in reducing the size of classes; and in particular he suggested that the regulation size of secondary school classes as well as that of primary school classes might be examined. Possibilities of meeting the desire of teachers for further training, either by supplementary courses or refresher courses or by a third year of training also merit exploration, and the Minister said that he has already asked the National Advisory Council on the Training and Supply of Teachers to consider the implications of a third-year course. The county colleges and the raising of the school-leaving age may also become possibilities within the next five years, and it will require sound judgment to decide which of them is in the best interests of the children.

Sir David spoke with the report of the working party on grants to training college students in front of him, but a few days before its publication. He had referred earlier in his speech to the special allowances which he had authorized for all teachers of advanced work, and which he believes will help to secure for the profession a better share of science and

mathematics graduates. This is in accordance with the report of the Appleton Committee as well as of the earlier reports from the committees of the Federation of British Industries and the National Advisory Council on the Training and Supply of Teachers in England and Wales. The Minister does not think, however, that this is a matter of money alone. He indicated that he had secured the co-operation of other government departments and of industry, and that with this help he hopes to recruit at least the minimum number of graduates required by the growing sixth forms expected in the years ahead; but he gave no indication of the supplementary measures being adopted to match either his sense of urgency or his confidence that this particular problem would be solved.

As regards the training colleges themselves, Sir David gave approval of the main recommendation of the working party as to the importance of securing uniformity in the grants made by local education authorities to students in teachers training colleges to cover expenses other than fees and boards. The report recommends that the grants should be fixed at a uniform rate for the whole country, roughly equal to the best rates now being paid, or about twice the present average, and sometimes three or four times the present grant. It also recommends that the parents' contribution should be assessed on the basis of the same income scale as is to be used for university awards. Sir David said that there would be further consultation with local authority associations before he authorized the introduction of the scheme, but meanwhile he had accepted the recommendations of the report.

Sir David also indicated that, as from next autumn, the basic allowance for board and lodging for holders of State scholarships would be increased by about ten per cent, and that State scholars who win a special prize or order of merit would be allowed to retain the cash value of the prize up to a limit of £100, without affecting the scholarship grant, provided the prize money is a single payment. The means test applied to parents' income would also be eased, both to bring somewhat higher incomes within the range of the grants and to increase substantially the allowance for parents with large families (see *Nature*, May 21, p. 881). Details of the arrangements were published on May 4, and Sir David said that he hoped the support of the local authority associations in working out these proposals would be continued.

The Minister said that he had not finished his survey of the problem of early leaving; but while he wished to see every area provide places for at least fifteen per cent of the children in grammar schools and technical schools combined, he stressed the desirability of fostering, besides the stream from grammar school to university, many strong and diverse streams leading from the secondary modern schools to the technical colleges, technological institutes and all other forms of higher education. In referring to the comprehensive school, Sir David emphasized the

value of the existing modern secondary schools and the limits which building and staffing problems place on experiments with new types of school. He suggested that it would be wiser to leave the question of the comprehensive school to the judgment of teachers themselves.

Sir David left the question of the Ashby report and adult education to the Parliamentary Secretary to the Ministry of Education in replying on the debate. In doing so, Mr. Dennis Vosper also said that there are to-day 10,900 graduate teachers of science and mathematics in our schools and that to meet our requirements this number should rise to 14,100 by 1960. At the present rate of increase, this is unlikely to be achieved; but Mr. Vosper did not indicate the steps the Minister has taken to accelerate the increase.

As regards adult education, Mr. Vosper said that, in addition to permitting higher fees and salaries for certain tutors, the Minister hopes to provide grants for a limited expansion next autumn in a few areas where there is special need. The Minister has also made it clear that he expects a further contribution towards the higher costs by an increase in fees or other means. Revision of the regulations is now being discussed with the responsible bodies. Much emphasis was laid on technical education in the debate, and Mr. Vosper stated that the provision for building technical colleges has been increased by fifty per cent during the year and that 514 courses have been approved as qualifying for the seventy-five per cent grant. Although he welcomed the co-operation with industry which finds expression in the so-called sandwich courses, Mr. Vosper did not meet Sir Hugh Linstead's query as to whether technical and technological education are not being confused and resources spread too thinly over a large number of colleges instead of concentrating on a carefully selected few.

Mr. Frederick Peert also challenged the Ministry for more imagination in regard to technical education; and although, as even this outline of the Minister's attitude indicates, there is no lack of imagination in Sir David Eccles's approach to the problem of education, it is equally clear that both he and his political opponents are in some respects too concerned to conform to party doctrines or to avoid disturbing particular interests to give full attention to the deeper issues involved. On one hand, the approach was clouded by subservience to a doctrine of equality no matter how much levelling down it involves; and on the other there is a disinclination to recognize the fact that no effective policy can hope to avoid offending some particular interests.

Those real issues are well displayed in Prof. W. R. Niblett's recent book "Education and the Modern Mind", though they were equally set forth by Dr. Eric James in the talks on a democratic education which he broadcast three years ago. Dr. James then disposed of the false idea of equality as contrasted with that of opportunity, and also of the idea that democratic education can be attained by a formula of administration or a technique or programme of instruction. Rather it is to be achieved by the creation of individual schools in which democratic

ideals are to be expressed in a multiplicity of day to-day personal relations between teachers and pupils and parents, between heads and their staffs, and between administrators and governors and schools. It will be achieved by schools which try to encourage the growth of individuality without anarchy, which stand for an ideal of equality utterly indifferent to social class or wealth, but are aware of excellence and in which the will of the majority is sensitive to the opinions of the best. It will be achieved in communities with a sense of social obligation without a sterile conformity.

There was some recognition on both sides in the House of Commons of the importance of co-operation between administrators and governors and teachers but save in respect of co-operation with industry in technical education, there was little awareness of the importance of the relations between the school and the community, between parents and staff. Whether we can create the type of schools which Dr. James describes depends, however, much more on the quality of the individuals who serve them than on patterns of organization or curriculum, and on the quality of the teaching staff, which in turn can be powerfully affected by the relations between school and community.

Both these factors, largely ignored in the debate, are well brought out by Prof. Niblett. Prof. Niblett emphasizes the extent to which the adolescent is affected by the society in which he is brought up, and the complexity of the views, ideals and traditions which make up any society. Whether men and women are adequate to the needs of the next half century depends, in fact, largely on whether certain qualities rather than others are fostered within them, and which variants within the main traditions of our society are allowed the greatest scope. Prof. Niblett is discussing primarily the schools; but his words apply equally to university education and to adult education. Above all else is his argument that among the greatest needs of our time are a new vision and a new depth of purpose in Western civilization, and that accordingly insight and feeling as well as thought are important, beliefs are necessary and mystery as well as knowledge have places in the mind of man.

It is from this point of view that Prof. Niblett develops his argument as to the importance of schools and universities being deeply representative of the nation they serve; but it should be noted that, in doing so, he faces frankly the issue of freedom. It is no totalitarian regime of rigid conformity which he advocates. He recognizes that there are strict limits to the range of choice and acts of will of the individual, and that it is desirable that a society should seek to influence the development of those choices and acts in certain directions rather than others. Nevertheless, he insists that in almost every situation there are choices to be made by the individual, and the real task of education is to help men and women to choose between following the traditions within them—not merely to teach them what to feel, what to think and when to act, but to help them actually to feel, to think and to act.

This is what marks off the free society from the totalitarian regime, and be it noted, it is what the

free society has continuously to preserve against the encroachments of any political party or social institution if freedom is not to decay. Here must be exercised the eternal vigilance which is the price of freedom, and nowhere more than in the process of helping the growing citizen to become more fully the possessor of the traditions which vitalize his society. On the skill, the wisdom and the vision with which the inevitable selection is done, the preservation of both the society and of freedom itself depends.

Prof. Niblett does not shirk the difficulties; but he insists that a first aim should be to enable the adolescent to choose for himself between the traditions growing within them. He insists, too, on the note of responsibility, and that the real makers and preservers of the standards, those who not only embody tradition but also extend the lines of belief, are the creative men and women of a civilization—whether poets, administrators, saints, statesmen or scientists. The test of greatness is whether men continue to find those with a reputation for being great to be the source of richness in themselves; the selection of traditions we exercise to help the adolescent must be determined by fundamental respect for the essential humanity in man. It must seek to prepare the adolescent to become responsible and to act responsibly and act alone.

A careful reading of the House of Commons debate suggests that Sir David Eccles grasps more clearly than some of his opponents why it is important, if a school is to be effective, that its influence should not run counter to trends approved by the parents of its pupils. Prof. Niblett does well to direct attention to this factor, and in his view one of the most urgent needs in English education is a much more whole-hearted effort to secure closer understanding between home and school. If new experiments, such as the comprehensive school, are to succeed, and the full benefit of any inherent advantages accrue, the important point is not rigid subservience to a political theory but to secure the full understanding and co-operation of all concerned; no time spent to that end will ever be wasted.

Because so much of this education of understanding takes place out of the class-room and in the home and elsewhere, Prof. Niblett's argument bears on adult education and university and technological education as well as the schools. It is part of the functioning of a democratic society; many of the strains and maladjustments in industrial as well as social and political relations are the outcome of its neglect—of failure to learn how to judge character or to sum up a situation or to appreciate values. All in some measure need such capacities; for although they are required particularly in the leader, the leader cannot lead without people who are ready to acknowledge leadership, and especially the leadership we need most—that of men in whom material values are subordinate to others. To educate for leadership is not, Prof. Niblett remarks, a matter of educating the leader only.

Once again we see the need for a close understanding between school and university and community. Prof. Niblett puts the whole problem of education in

the context of freedom, and raises the fundamental question whether, in fact, the present system of education and educational institutions in Britain fits the society in which we live. That question, and the related one whether the needs of our society demand an attempt by the various vehicles of adult education to modify group attitudes to education, and especially higher education, are the questions that have to be answered before we attempt to re-shape educational institutions to serve more effectively the varied needs of a free society. They were raised in the report on early leaving and in other reports; but Prof. Niblett challenges even more forcefully the deeper thinking that must precede any such attempt. His book indicates, too, why we must carry even further than in the recent debate on education the attempt to take education policy out of party politics. An adequate educational policy in a free society is much more than a matter of finance: it is above all a matter of public understanding and support, of the exercise of restraint, of sound judgment and of sustained interest; to carry through a policy and give those responsible for its execution the confidence which will draw to the profession men and women not only of technical competence but also of high ideals and deep human sympathies.

ENGLISH MATHEMATICIANS OF THE SIXTEENTH AND SEVENTEENTH CENTURIES

The Mathematical Practitioners of Tudor and Stuart England

By Prof. E. G. R. Taylor. Pp. xi+443+12 plates. (Cambridge: At the University Press, 1954. Published for the Institute of Navigation.) 55s. net.

ONE of the most neglected aspects of the history of science in England has been the development of practical mathematics before the eighteenth century. Practical mathematics had to free itself from a deep-rooted apathy, and even repugnance, in the minds of many educated men who were brought up on the classics. It had also to defend itself from the suspicions of the unlearned, who often feared that the instruments and books of mathematical practitioners were devices of the black arts.

Yet this hostility was overcome very largely through the efforts of ever-growing numbers of humble mathematical practitioners and teachers, who were centred not in the universities, but in London. By the early years of the seventeenth century, these instructors "in the Mathematikes" were well established, and their advertisements became commonplace in the increasing flow of Stuart text-books on the elementary application of mathematics, especially geometry and trigonometry, to the practical problems of navigation and surveying, and that gentlemanly hobby of dialling.

One of Prof. E. G. R. Taylor's main achievements in this well-produced book is to bring to light the important part that these men played in propagating mathematical knowledge, and in providing a broad-based foundation for the work of the more famous mathematical scientists of seventeenth-century England. Better-known figures are not left out, however, when, as the author remarks, "without loss of dignity,

a Thomas Hariot shows the sailor how to manage his cross-staff, or an Isaac Newton polishes his own speculums".

Emphasis is laid also on the significant role of the instrument-makers, who came in the main during Elizabethan times from the ranks of the engravers, and later, as science and technology advanced, from among the clock-makers, and finally were drawn from the spectacle-makers and glass-grinders. A new profession had come into being that was to produce some masterpieces in the eighteenth century.

The book is divided into three parts. The first section describes the vicissitudes and progress of the practical mathematicians from the early years of the Tudor era until 1715, when mathematics had become highly esteemed not only for its utility on land and at sea but also as a means for expressing newly discovered scientific truths about the nature of the universe itself. In the middle section, short biographies of 582 mathematical practitioners are given, and the concluding section is a chronological bibliography, with descriptive notes, of more than six hundred mathematical treatises that were published in England during this period.

Thus Prof. Taylor's latest book follows the pattern of her earlier volumes on Tudor and early Stuart geography, which also carried out accomplished forays into a little-explored and allied field. "The Mathematical Practitioners of Tudor and Stuart England" will become an invaluable reference book for historians of science, as well as an authoritative account for the general reader who wishes to know about this important aspect of the development of contemporary civilization. The Institute of Navigation must be congratulated for having sponsored this valuable book.

D. P. J. Wood

CULTIVATION OF COCOA

Cocoa

By D. H. Urquhart. (Tropical Agricultural Series.) Pp. xix+230+107 plates. (London: Longmans, Green and Co., Ltd., 1955.) 35s. net.

THIS book was compiled for the practical cocoa grower by a former director of agriculture in the Gold Coast. It is a composite effort, three of the chapters having been written by specialists. In his foreword, Sir Geoffrey Clay, agricultural adviser to the Secretary of State for the Colonies, stresses the fact that cocoa is a 'favoured' crop, in that there is little fear for many years to come that production will exceed consumption. This should furnish a strong incentive for the improvement of agricultural practices in countries where the crop is already established and for its extension to other areas which may be suited to it. The information given in this book should help particularly in the introduction of the crop to new areas. The more difficult problem of increasing or maintaining production in already-established cocoa-growing countries where, apart from the effect of pests and diseases, yields are rapidly diminishing is scarcely touched upon, doubtless because so little is known about the manuring of cocoa and the renovation of worn-out cocoa soils, which is a more difficult problem than the rehabilitation of existing cocoa plantations on good soil.

The book is divided into fifteen chapters. The first is introductory. The second concerns the botany of cocoa, and in it the late Prof. R. E. D. Baker, of

the Imperial College of Tropical Agriculture, Trinidad, gives a clear and interesting account of the nomenclature and classification of the main types of cocoa in regard to pod and bean characters. The third chapter deals briefly with the climate under which the cocoa tree grows successfully, though it does not state the precise limits of temperature tolerance. The fourth chapter, by Prof. F. Hardy, of the Imperial College of Tropical Agriculture, deals with cocoa soils from the concept of root-room, and traces their derivation from forest soils and their various stages of deterioration under the customary methods of cocoa cultivation at present in vogue. Some means for their improvement are briefly considered, including mulching and manuring.

The next three chapters discuss practical methods of establishing and maintaining a 'seedling' cocoa plantation, and of producing rooted planting material for use in the more modern 'clonal-cuttings' plantation. The selection of suitable clonal material is not described, however, nor are the relative merits of seedlings and cuttings discussed, though the vexed questions of planting-distance and the value of overhead shade are considered at some length. The close connexion between shade and cocoa nutrition is perhaps not sufficiently stressed. The safe conclusion is reached that "all cocoa in the young seedling stage must be shaded", though, when the trees reach maturity, mutual shading may amply suffice and shade-trees may then be removed. Harvesting and the preparation of cocoa for the market, by fermentation and drying the beans, are described in Chapter 8.

The present cocoa industry of West Africa is described in the next chapter, in which its spectacular growth in the Gold Coast (which produces most of the world's crop, valued at more than £35.5 million in 1950) and its dependence on the existence of ample reserves of untouched forest land and the control of swollen-shoot virus, capsid bugs and black-pod fungus, are fully discussed. "The future of the peasant industry", it is considered, "lies chiefly with the people themselves", and their ability to take advantage of the results of scientific research. It is interesting to note that the cutting-out campaign, which was started in the Gold Coast in 1946, "has saved the main producing areas of Ashanti Province and Togoland . . ." from the complete destruction of cocoa trees by the swollen-shoot virus.

The process of rehabilitation, as evolved in Trinidad, is next described by Prof. C. Y. Shephard in Chapter 10. Rehabilitation is defined as "a simple modification of the traditional system of cocoa cultivation on good soils", in which inferior trees are systematically replaced by high-yielding clonal cuttings. It is not recommended for bad soils, and quite rightly so, because bad soils present a compact, nearly structureless surface layer devoid of crumb and humified litter, within which fibrous cocoa roots cannot adequately ramify and absorb essential nutrients. A suitable procedure is outlined; this involves thirteen operations, spread over five years, fertilizer applications being given annually in the last three years. It is too soon yet to say whether or not this procedure is likely to be completely successful, or how efficacious the use of fertilizers may prove to be.

Pests and fungal and virus diseases of cocoa are described systematically in the next two chapters. The rest of the book (three chapters) deals with grading, very briefly with cocoa research in Trinidad at the Imperial College of Tropical Agriculture and

in the Gold Coast at the West African Research Institute, and with world production and consumption of cocoa. In addition, there are eight appendixes dealing with certain technical aspects of growing cocoa, including soil surveying, farm costing, propagator design and small-scale fermentation. A notable feature of the book is the large number of excellent photographs and ten colour plates. Selected reference lists are given at the end of each chapter, and there is a good general index.

The renewed interest during recent years in the growing of cocoa and in the results of scientific research on problems connected with it has created an urgent need for a book such as this, and its author deserves the highest commendation for his successful attempt to perform a useful but difficult task.

THE ENGLISH CLIMATE

The English Climate

By Dr. C. E. P. Brooks. Pp. x+214. (London: English Universities Press, Ltd., 1954.) 12s. 6d. net.

IN this engagingly written volume Dr. C. E. P. Brooks describes the climate of Britain in relation to the major factors controlling it as well as the various weather processes and seasonal vicissitudes which make it up. Local climates are considered in much detail, largely from the human point of view in relation to such matters as bracing and relaxing conditions and the suitability of places for residence, holidays and retirement. In a discussion of 'sultry' conditions as defined by certain limits of temperature and relative humidity, there is an obscure statement on p. 114 to the effect that exposure to sunshine raises the body temperature by several degrees. This presumably refers to the external surface temperature, not the internal blood temperature, which would indicate high fever. In the chapter on "Fog and Soot" much prominence is given to the disastrous 'smog' of December 1952. The heavy death-rate from bronchitis and pneumonia is apparently attributed in the main to sulphur dioxide and soot; but it should be noted that some medical authorities maintain that, if this long-continued four-day fog had not been associated with freezing temperature in London, the mortality would have been notably less. No reference is made in this chapter to modern smoke-abatement practices and changed methods of domestic heating as bearing on the experience of the older generation that London fogs to-day have lost the sooty blackness of Victorian times.

Dr. Brooks's review of notable weather events in modern times, including storms, droughts, frosts and heat spells, leaves little unnoticed. There is no mention, however, of the prolonged intense frost in southern England during November-January 1890-91, though the famous blizzard in Devon and Cornwall which followed in March is accorded full honours. The author is right in maintaining that, while English weather is sometimes unpleasant, wild and even dangerous, these are more than compensated by many delightful moods. Essentially moderate, a stimulating variety is, he declares, to be reckoned among its greatest assets. To the more imponderable assets one would add the changeful skies and picturesque cloud scenery to which, indeed, many generations of our landscape painters have done ample justice.

L. C. W. BONACINA

SOCIAL MEDICINE

The Meaning of Social Medicine

By Iago Galdston. Pp. xii+137. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1954. Published for The Commonwealth Fund.) 22s. net.

DURING the past sixteen years there has been much talk of social medicine, though its advocates are not always clear as to its scope and differentiation from clinical, preventive and 'socialized' medicine. This book records the inquiries of the Secretary of the Medical Information Bureau of the New York Academy of Medicine into the subject.

In 1848 Jules Grévin seems to have coined the expression "social medicine", and defined it "as the congregate function of the separate activities differently termed medical police, public hygiene and legal medicine". Many authorities regard social medicine as the sum total of all and everything that bears on medicine and the social organism. The late Prof. René Sand gave a list of numerous components of the medical and sociological sciences which comprise social medicine. All these can be of use to the subject. But social medicine itself "must be and is something more than the sum of the sciences". It is not a new name for an old discipline.

When the chair of social medicine with its Institute was founded at Oxford in 1942, the main purposes were set out as follows: "To investigate the influence of social, genetic, environmental and domestic factors on the incidence of human disease and disability. To seek and promote measures, other than those usually employed in the practice of remedial medicine, for the protection of the individual and of the community against such forces as interfere with the full development of man's mental and physical capacity".

The subject was so attractive that the late John Ryle forsook the regius chair of physic at Cambridge to become the professor of social medicine at Oxford. Under his direction, important investigations were carried out; but when he died social medicine languished in the University. This is not surprising, for the science of social medicine is still in the making, and stern economists desire to see results which justify expenditure. Nevertheless, Oxford's example, initiated in 1939, was followed by a chair of social medicine at Birmingham and a lectureship at Sheffield, while the chair of public health at Edinburgh became the chair of public health and social medicine.

In social medicine there is a vast field of potential research, in many respects still a virgin and unexplored territory. The wide conception of the subject demands access to many branches of learning. Hence its essential growth should be in a university. Dr. I. Galdston desires similar experiments to be made in the United States. He writes: "It would be well if one or more medical schools, preferably those closely associated with universities or schools of liberal arts and in close relations with hospitals . . . would institute an experiment in the *gestalt* of social medicine. . . . It is not at all unlikely that it might have as great an effect as did that other experiment in medical education initiated by Welch and Osler some sixty years ago". To British pioneers in social medicine and to those who promoted the first chair of social medicine in Great Britain, these words are welcome and encouraging.

ARTHUR S. MACNALLY

THE 156-in. CYCLOTRON AT LIVERPOOL

By M. J. MOORE

Nuclear Physics Research Laboratory, University of Liverpool

EARLY in 1948, it was shown that π -mesons could be produced in numbers by the bombardment of matter by α -particles produced in the Berkeley synchrocyclotron, and shortly afterwards it was proved that high-energy protons in the same machine were even more effective. The threshold for π -production by protons is about 160 MeV.; but it soon became clear that energies considerably above this value were needed for the production of significant numbers of these mesons.

After the War, Sir James Chadwick, who was then professor of physics at Liverpool, determined to initiate the building of a high-energy machine in his department. By May 1948 the above considerations had crystallized his ideas in favour of a synchrocyclotron of energy about 400 MeV., involving a magnet with poles of 13 ft. diameter. This diameter was determined by the length (32 ft. 6 in.) of the corresponding horizontal yoke plates which could be machined in one stage by the equipment available in Britain. Subsequent developments in cyclotron physics have made us wish that the size could have been somewhat larger.

Sir James Chadwick obtained funds from the Department of Scientific and Industrial Research for the synchrocyclotron, and the University received funds for the associated buildings through the University Grants Committee. The design and commissioning of the machine was the responsibility of the University, and the development contract for constructing the machine was let to the Metropolitan-

Vickers Electrical Co., Ltd., in July 1948, and at the same time the building work was started by Bovis Ltd. In the autumn of 1949, Prof. H. W. B. Skinner succeeded Sir James Chadwick, when the latter retired.

The period of building the machine was in many ways a difficult one on account of shortages of materials and trained man-power. However, the machine progressed steadily, if sometimes disappointingly slowly, until, in the middle of May 1954, an internal beam was first observed. By the beginning of July, the cyclotron was working regularly with an internal beam of the expected energy and current.

Experiments were then started on the extraction of the beam by a method described by Tuck and Teng and developed by Le Couteur², and by the end of December a beam of high intensity had been extracted and focused into a suitable spot for experimental work. The experimental programme, concerned with the properties of fast protons, neutrons and pions, was begun on a regular basis on about January 1, 1955.

The Cyclotron Building

The main feature of the 156-in. cyclotron block is the cyclotron room with two working floors, one at about street-level and the other 8 ft. below. Adjoining the cyclotron room is a large ante-room for experimental work.

Above these are the cyclotron auxiliary equipment room, a motor hoist for raising and lowering a 30-ton screening door, a ventilation plant room and the air-blast water-cooling tower. A bridge, which carries in addition to the normal services all cable for the control of the cyclotron, joins this building to the laboratory block in which the control and particle-counting rooms are housed. As a large portion of the 156-in. synchrocyclotron room is below ground-level, it was necessary to excavate to a maximum depth of 30 ft. into sandstone. The whole of the basement was water-proofed with asphalt and the concrete oversite built to a thickness of 2 ft. From this the walls were constructed, the majority being 6-ft. thick mass concrete, although the wall dividing the cyclotron room from the ante-room is 12 ft. thick. The 46-ft. wide roof over the cyclotron is of heavily reinforced concrete 5½ ft. thick.

As a further protection from radiation, the 6-ft. external wall on two sides have an additional thickness of pulverized sandstone which was excavated from the

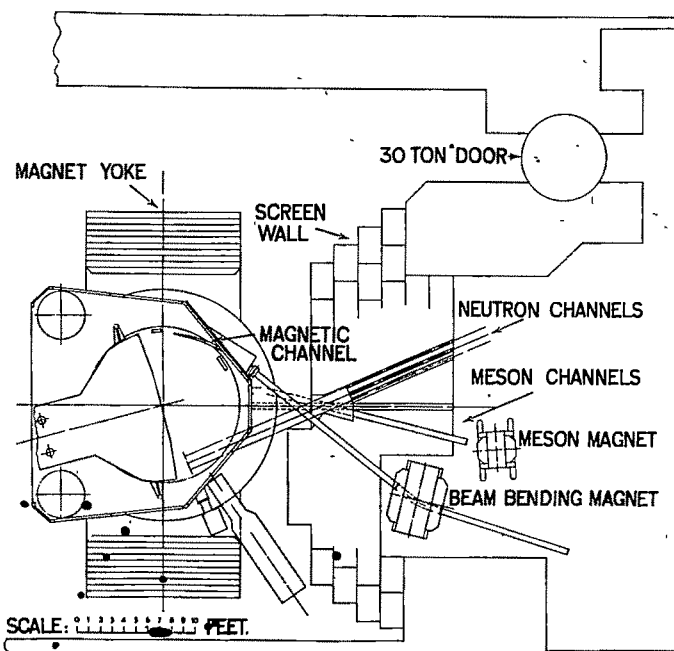


Fig. 1. Plan of cyclotron showing disposition of some of the associated apparatus

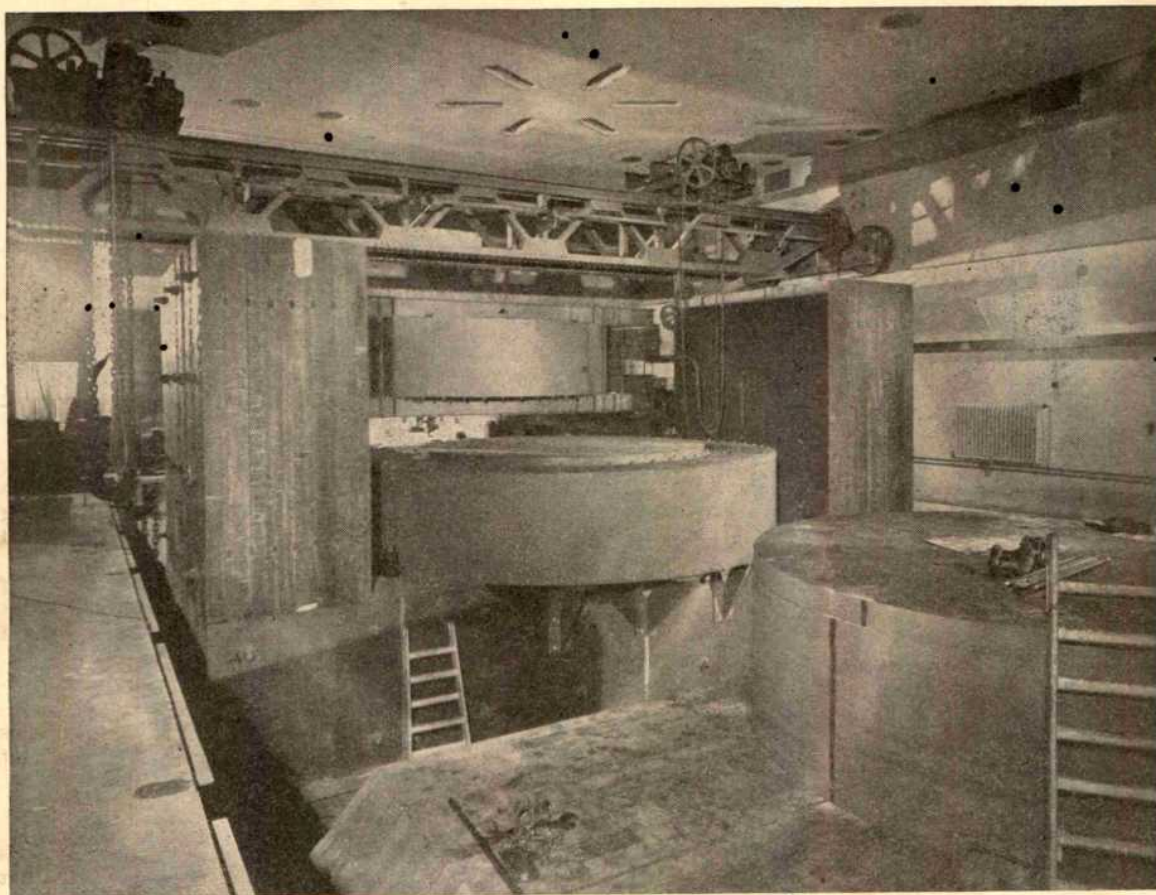


Fig. 2. The magnet in course of erection. The top coil is being moved into position prior to assembling the 13-ft. diameter top pole-pieces and top horizontal plates, which are visible in the right foreground

magnet pit, and extends 15 ft. beyond the outside face of the cyclotron wall. This packing, which rises to the height of the cyclotron room ceiling, is retained in position by a brick wall. At the maximum there is a 21-ft. wall of protective concrete, pulverized sandstone and brickwork around two sides of the cyclotron room. The third side, which faces the ante-room, has a wall of mass concrete 12 ft. thick. The fourth side has been built into the solid rock. To provide a working floor around the cyclotron at the same level as the ante-room, a floor was constructed of steel columns and beams supporting open grid steel panels. This floor is designed to take a maximum load of 70 tons (that is, the two coils) on any set of four supporting columns. It may also be readily dismantled for the removal of equipment from the lower floor-level.

For the erection of the magnet a 30-ton overhead crane was installed and supported on reinforced concrete beams which form an integral part of the concrete walls. A supplementary 2-ton crane is provided for working between the front of the cyclotron and the 12-ft. thick concrete wall separating it from the ante-room.

There are two methods of entry from the ante-room to the cyclotron room. Easy access to the cyclotron room is gained through a special doorway which takes the form of an opening through the 12-ft. concrete wall. This is closed by lifting into position a 7-ft. diameter steel cylinder filled with sand and weighing about 30 tons. For the removal of heavy

plant and equipment, an opening 23 ft. wide $\times$ 9 ft. high has been left in the 12-ft. concrete wall. Prior to the commencement of experimental work the cyclotron side of this opening was sealed with steel-loaded concrete blocks manufactured to a fairly high degree of accuracy. Each of these blocks weighs $1\frac{1}{2}$ tons. The aggregate used weighs 300 lb. per foot cube (density 5) and the total thickness equivalent is 24 ft. of ordinary concrete. Channels are provided in the wall to allow beams of particles to enter the experimental room.

During the construction of the cyclotron block, 6,000 tons of sandstone and rock were excavated and 7,100 tons of concrete used. More than 5,000 tons of sandstone was eventually pulverized and used as shielding material.

The Cyclotron

The magnet of the Liverpool cyclotron has cylindrical poles, 153 in. in diameter with a maximum gap of 15.5 in. near the centre and a minimum of 11.5 in. at the edge. The yoke is built up from mild steel plates of an average thickness of 6.5 in. and a maximum weight of 23 tons. The poles are made up of disks, the maximum weight (that of the pole tips) being 30 tons each. The total weight of steel is 1,650 tons.

The energizing coils are made from 1.5-in. square aluminium conductor with a $\frac{3}{8}$ -in. diameter hole for water cooling. Each coil contains about 4.5 miles of conductor and weighs 32.5 tons. The cooling water

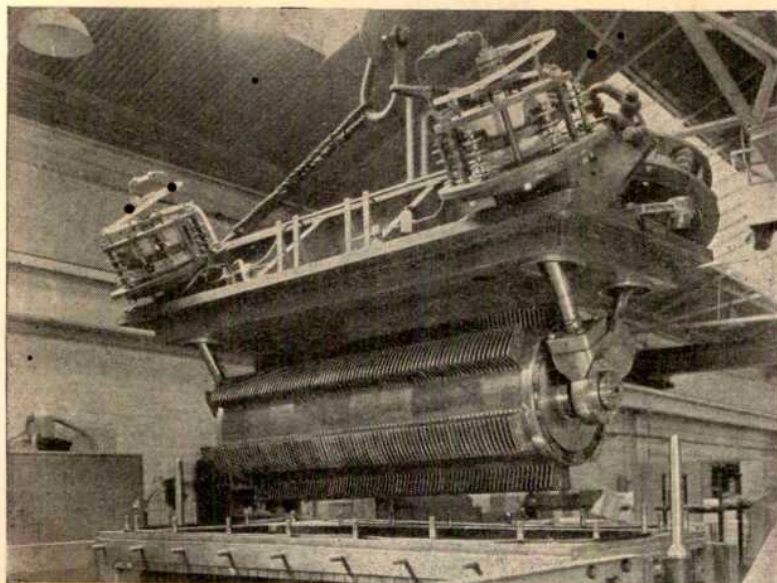


Fig. 3. The 24-in. diameter rotating condenser, which runs on 2.5-in. diameter roller bearings. The driving flange can be seen on the right-hand side. The molybdenum brushes for by-passing the radio-frequency from the bearings are between the end-plate of the condenser and the bearing housing

for the coils is demineralized and degassed in order to reduce corrosion.

With a power input of 840 kW., the centre field is 18,900 gauss, and at the maximum usable radius of

71.9 in. (where $n = -\frac{r}{H} \frac{\partial H}{\partial R} = 0.2$) the magnetic

field is 17,520 gauss. This corresponds to a proton energy of 410 MeV.

The radio-frequency system is similar to the three-quarter wave system developed by MacKenzie³ for the Berkeley 184-in. cyclotron, where the dee is coupled through a section of transmission line to a variable capacity. The other side of the capacity is connected through a stub line to ground. It is possible to proportion the system so that it behaves like a single transmission line shorted at one end and open at the other with a capacity placed about one-third of the total distance from the shorted end. The capacity of the condenser will determine the frequency of resonance. As the capacity of the condenser increases, the minimum frequency is approached and the system behaves like a resonant quarter-wave line. As the capacity approaches zero, the maximum frequency is approached and the system behaves like a resonant three-quarter-wave line. The frequency-range required for protons is 29.2–18.9 Mc./s.

The variable capacity is built as a rotating condenser with six sets of protruding vanes which intermesh with sets of stator vanes attached to the dee-line and stub-line. It weighs about 3,000 lb. and is built up from ten sections of 'Hidurel' copper alloy. Each section is machined to form a number of 24-in. diameter disks with six blades cut in each disk. The total number of disks is eighty and the overall length of the condenser is 71 in. A variable speed electronically controlled d.c. motor drives the condenser through a rotating vacuum seal up to a speed of 2,000 r.p.m.

The dee, dee line and stub-line have water-cooled copper skins built up on a light aluminium-alloy

frame. The dee is suspended in the vacuum tank on four quartz insulators. The stub line stands on six porcelain insulators and is 'grounded' through a condenser.

D.C. biasing voltages are applied to the dee, stub line and rotating condenser to collect stray electrons which would otherwise oscillate in the radio-frequency field, cause discharges, and heavily load the oscillator.

The ion source follows conventional practice, with a tungsten or tantalum filament heated by a d.c. generator. The accelerating potential is supplied from a variable output d.c. generator.

The main vacuum tank is made of stainless steel and the condenser and stub line tanks of mild steel. The total volume to be evacuated is 30,000 litres and the pressure can be reduced to 3×10^{-6} mm. mercury by two 80-cm. diameter multi-stage oil diffusion pumps with a combined speed of 24,000 litres/sec. at 10^{-4} mm. mercury. The actual operating pressure, on account of the necessity for an in-leakage of hydrogen, is about 5×10^{-5} mm. mercury. Three air locks are available for use. One of these contains an adjustable probe target which can be moved in to any radius to select a proton beam of desired energy. The larger one enables apparatus up to 11 in. cube to be inserted for irradiation without impairing the vacuum, and the third is for use in the replacement of ion-source filaments. Although higher radio-

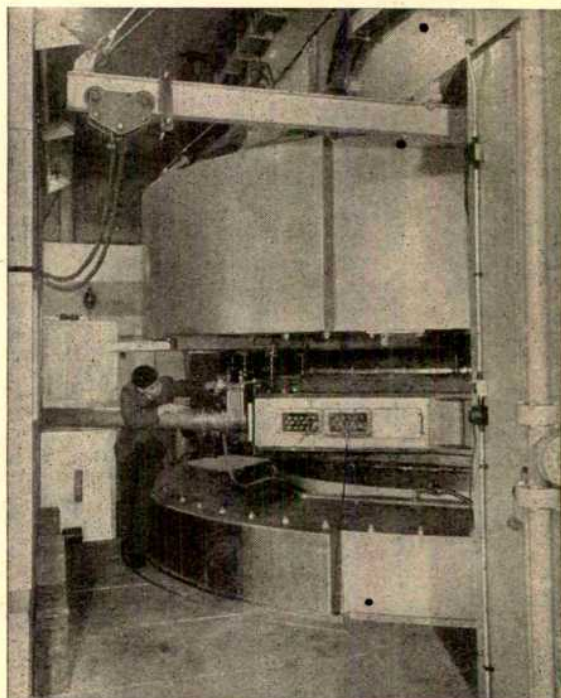


Fig. 4. The beam-exit side of the cyclotron, showing the 6-in. diameter proton tube leaving the vacuum tank and passing through the dense screen wall on the left

frequency voltages are available, the machine is at present being operated with a 'peak' dee voltage of 6.5 kV. corresponding to a power input to the oscillator of about 14 kW.

The d.c. biasing voltages for the dee, condenser and stub are 1.2, 1.0 and 3.0 kV. respectively for most satisfactory operation.

The modulation frequency used is 110 cycles per second. The mean beam current is more than 1 microampere, but no serious attempt has so far been made to increase the output of the cyclotron beyond this current.

Extraction of the Beam

The proton beam has been extracted by using the 'peeler-regenerator' system of Tuck and Teng¹ and developed by Le Couteur², who laid down rigid conditions for successful extraction. A note by Crewe and Le Couteur is being published in the *Review of Scientific Instruments* and a full account will shortly be published by Le Couteur, Crewe and Gregory in the *Proceedings of the Royal Society*.

The beam is extracted from the cyclotron by building up the amplitude of radial oscillations without introducing excessive vertical instability. This is realized by introducing two magnetic discontinuities at the 69-in. radius of the cyclotron and at 68° apart.

The radial oscillations, which build up exponentially with the number of transits of the beam through the magnetic extraction system, cause an increase in the separation of successive orbits. Eventually, after about fifteen turns, the orbit separation is sufficient to allow the beam to jump 1 in. into the mouth of a magnetic channel. This consists of pairs of steel bars arranged side by side. At the entrance the gap between them is 0.5 in. and their thickness is 0.25 in. The centre of the channel mouth is at the 72-in. radius. The reduced field in the channel allows the protons to pass out of the main field of the magnet.

The effects of the channel, peeler and regenerator on the median plane had to be compensated for by the introduction of additional magnetic material.

After adjustments of the components, and by centralizing the median plane by by-passing a fraction of the current through one of the magnet coils and also using the optimum total magnet current, it was found that 10 per cent of the circulating beam entered the channel. After travelling down the 6-ft. channel, the beam emerging from the cyclotron amounts to 3 per cent of the circulating beam over an area of $1\frac{1}{2}$ in. square.

With a circulating beam of 1 microampere, an extracted beam of protons of 383 MeV. energy is available in the experimental room at a current of 3×10^{-2} microampere. About 70 per cent of this beam has been focused on to an area of 0.5 sq. in., at a distance of 20 ft. from the focusing magnet, giving a flux of 4×10^{10} protons/cm.²/sec. This is larger than that of any other similar machine by a factor of at least 1,000.

Neutrons having energies between 200 and 400 MeV. are available.

Provision is made for the extraction from the tank of pion beams having energies of 150 MeV. and 96 MeV.

The normal flux of the extracted 96 MeV. π^+ and 96 MeV. π^- particles is 20/cm.²/sec. and 100/cm.²/sec.

respectively. A quadrupole focusing magnet is being constructed to increase these intensities.

96 MeV. π^+ particles can be produced by a external proton beam with a flux of about 5×10^8 /cm.²/sec.

¹ Tuck, J. L., and Teng, L. C., Institute of Nuclear Studies, 170 Synchrocyclotron Report, III (Chicago, 1954).

² Le Couteur, K. J., *Proc. Phys. Soc.*, B, 64, 1073 (1951); 66, 25 (1952).

³ MacKenzie, K. R., *Phys. Rev.*, 74, 104 (1948).

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH*

REPORT FOR 1953-54

Research Associations

THE formation during the year of the British Steel Castings Research Association and of the Research Association for the Chalk Lime Industry brings a total of research associations in Britain to thirty-seven, while there are also four co-operative industrial research organizations which have not yet reached that status. The British Steel Castings Research Association, which is supported by 74.5 per cent an industry with a turnover of £25 million of carbon low-alloy and high-alloy steel castings, is to construct a fully-equipped foundry experimental station, and its block grant of £15,000 per annum for five years from April 1, 1954, is conditional £30,000 being received from industry, with additional £100 for each £100 from industry up to a maximum of £10,000. Work already being carried out includes studies of the influence of moulding materials upon the incidence of hot-tearing, or lamination of a steel casting while still at high temperature, the adherence of sand to steel castings, the development of improved and simplified forms of non-destructive testing, and of the dust-flow characteristics of the swing-frame grinding machines used in steel foundries, which have led to a device providing a simple but effective means of controlling dust from them. Research on the causes of silicosis further supported the view that polymerization of silicic acid at critical hydrogen ion concentration is a major factor in the growth of silicotic tissue.

New terms of grant were offered to ten research associations during the year. Those for the British Flour Millers' Research Association—a block grant of £20,000 per year for five years, conditional upon receiving £30,000 from the industry; with an additional £75 for every £100 received from industry up to a maximum of £3,750—embody a return to normal conditions of grant in place of the special arrangements made during the Second World War, when the Association's activities were taken under control of the Ministry of Food. Work during the year included further investigation of the chemical changes induced in flour by the oxidizing agents used as improvers and by atmospheric oxygen. A systematic investigation of the effects of variation in temperature of wheat passing on to the first break rolls indicates a considerable advantage in warming the wheat 100-110° F. immediately before the first break and then cooling the resulting ground stock before further treatment. A study of inhibitors of germination at seedling growth occurring naturally indicates that

* Continued from p. 965.

extracts from oats are more active than those from wheat.

The overall effect of the Advisory Council's recommendations for the remaining nine research associations is to raise by about 40 per cent the minimum income which they are required to raise from their industries to qualify for grant and to reduce the block grant by about 20 per cent, the aggregate of the additional grants for which they can qualify being also slightly reduced. Thus, the British Cast Iron Research Association, for the five years from July 1, 1954, will receive a block grant of £40,000 per annum, conditional on receiving £100,000 from industry, and an additional £80 for each further £100 from industry up to a maximum of £16,000. Apparatus has been constructed for applying the vacuum heating method to determine hydrogen in cast iron, and work has continued on defects arising from the vitreous enamelling of iron castings and also on the effect of under-stressing on the fatigue properties of nodular cast iron. A correlation has been obtained between the percentage of cracked castings and the amount of enamelled scrap included in the cupola charges, while further work has shown that the fluidity of hypo-eutectic cast iron increases with carbon equivalent for a fixed pouring temperature.

The British Coke Research Association, which will now receive a block grant for £20,000 per annum conditional on obtaining £80,000 from industry, with a further £50 for every £100 from industry up to a maximum of £20,000, continued its fundamental studies of coke formation, the nature of coking coal and the reactivity of carbon, which have now established that the primary structure of coke and 'amorphous' carbons has two principal components: minute graphite layers, which may be present singly or in clusters of parallel but randomly orientated layers; and unorganized carbon atoms or amorphous carbon which, on X-ray examination, shows no extended regular arrangement. Investigations also continued on the influence of the chemical and physical properties of coke, on its performance in the blast furnace, and on the standardization of tests for the efficiency of coke-oven plant equipment. An improved method for determining naphthalene in coke-oven gas has been developed, and in South Wales a survey of the thermal and material balance of a blast furnace under normal operating conditions initiated a study of the wide range of problems concerned with the use of coke in blast furnaces.

For the period April 1, 1956, to March 31, 1959, the British Hat and Allied Feltmakers Research Association will receive a block grant of £9,000 per annum, conditional on receiving £12,000 from industry, with up to a further £5,000 on a cent per cent basis. Fundamental research on rabbit fur and the carotting process and on the physical characteristics of shellac in relation to the proofing process continued, and progress has also been made in the complex and difficult problem of assessing the different types of damage to wool noils and their relation to the behaviour of the noils in processing, as well as in the study of the physical properties of felt. The fundamental studies of carotting have led to mathematical equations relating the degree of carotting to the composition of the liquor and to the amount of liquor applied to the fur, for both mercuric and non-mercuric-carotting agents, which have already found industrial application. From July 1, 1957, until June 30, 1959, the Hosiery and Allied Trades Research Association will receive a block

grant of £20,000 per annum, conditional on obtaining £40,000 from industry, with up to a further £8,000 on a cent per cent basis. During the year the Association's consulting service has afforded substantial savings to the industry, and among its wide range of technological investigations, excellent progress has been made in eliminating the variations in dimensions and quality of knitted fabrics and garments. Good results were obtained in factory trials of the Association's enzyme method of removing 'seeds' from cotton, and detailed studies of the bending and torsional properties of hosiery yarns and of yarn friction are in progress.

The Lace Research Association will receive a block grant of £12,000 per annum for the period January 1, 1956, to December 31, 1958, conditional on receiving £15,000 from industry, with up to a further £5,000 on a cent per cent basis. The Association's textile testing work increased, and there was a 30 per cent increase in the rate at which members submitted problems. A study of the mechanical motions of the lace machine was inaugurated, and much time was given to the investigation of the physical properties of the yarns made from new fibres. Steady progress was made in the improvement of 'Lacra' lubricant, and different grades have been developed to suit variations in the gauge and type of machines in the industry. For the period October 1, 1957, to September 30, 1959, the British Launderers' Research Association will receive a block grant of £12,000, conditional on obtaining £25,000 from industry, with up to a further £10,000 on a cent per cent basis. Studies of dirt removal and redeposition were extended to include the relation of fabric composition and construction to dirt removal and redeposition. A rapid small-scale method was devised for the extraction and estimation of grease which has proved satisfactory for use in the textile industry, and work on the effect of alkalinity on the behaviour of wash liquors has led to the development of a recommended process for wool washing. Other work has included trials of 'dipless' washing machines, the washing of rayon colours, and problems arising out of the use of fluorescent blues or 'optical brighteners' in domestic washing powders and the staining of grease-resistant or embossed finishes by albuminous material.

The Research Association of British Rubber Manufacturers, which during the year completed its removal from Croydon to Shawbury, near Shrewsbury, will receive a block grant of £17,000 per annum for the period January 1, 1954, to December 31, 1955, conditional on obtaining £30,000 from industry, with up to a further £13,000 on a cent per cent basis. The terms will be further modified for the following three years. In fundamental studies on flow characteristics, with special reference to the high rates of deformation which occur in factory processes, unexpected features have been found which may explain the behaviour of rubber during extrusion from a die. Fundamental work on the mechanism of reinforcement has brought an explanation of this baffling phenomenon in sight, while the investigations on deterioration or ageing of vulcanized rubber by atmospheric oxidation, concerned particularly with the powerful aggravating effects of metals such as copper and also with the action of 'sequestering agents' intended to render these metals harmless, are building up a picture of the complex chemical reactions involved in oxidation and its prevention. A start has been made with operational research, or more specifically, productivity surveys of the basic

operations of masticating and mixing unvulcanized rubber, which represents an annual expenditure of some £3 million in Great Britain, and, with a grant from Conditional Aid funds, the Association is preparing a series of technical manuals presenting the results of its work. The four projected will deal with compounding vulcanized natural and synthetic rubbers; electrically conductive and anti-static rubbers; ebonite; and chemical analysis and testing of rubber and raw materials used in rubber manufacture.

For the five years from April 1, 1954, the British Shipbuilding Research Association will receive a block grant of £40,000 per annum conditional upon obtaining £120,000 from industry, with an additional £100 for each £300 from industry up to a maximum of £10,000. A comprehensive series of tests, covering both propulsion and resistance, in ship-model testing-tanks on a range of models of ocean-going merchant ship forms has provided data leading to improvements in hulls, propellers and all ship/propeller combinations. Reliable data have also been secured for the first time about the resistance of a full-size ship, and considerable savings in steel as well as improvements in the construction of the ship have resulted from the work of the Association's structure-testing establishment at Glengarnock.

It has seemed appropriate to select for mention the work of the research associations the terms of grant of which have been reviewed during the year, so that an indication can be given of their contribution to the national welfare in response to these grants. Of the work of the remaining research associations, reference can only be made here to a few points of interest. Thus, the British Baking Industries Research Association has extended its work on the mechanism of crumb-softening action, the effectiveness of acetic and propionic acids as inhibitors of rope in bread, and, in collaboration with the Medical Research Council, the Ministry of Food and the British Flour Millers' Research Association, on the effect of flour and bread improvers on the health of the consumer. The British Cotton Industry Research Association has continued work in the field of productivity and on blends of various textile fibres to produce yarns and cloths with specific predetermined properties. The British Electrical and Allied Industries Research Association is still extending its network analyser, and its dispersion meter has found a new and valuable use in determining the completeness of the drying of transformers and cables during manufacture. A three-year survey of the incidence of fires in wiring installations is complete, and three full-scale models of its all-electric dryer for grass and grain are in use on farms; fundamental research on ferroelectrics has revealed the presence of both ferroelectric and anti-ferroelectric properties at different temperatures in single crystals of a niobate. The sources of germanium in Britain for semi-conductor devices was also surveyed. The British Non-Ferrous Metals Research Association reports that the investigation on melting copper alloys is now paying dividends: with the improved linings, several hundred melts of phosphorus-deoxidized copper can be carried out in place of fifty without relining the furnace. A simple treatment has been developed by which the corrosion resistance of copper alloys used in heat exchangers may be very considerably increased, and investigation of the conditions for producing lead of suitable and stable grain-size may lead to the more efficient use of lead for water pipes. The Wool Industries Research Association has developed a chromato-

graphic method of analysis for lanthionine, and has designed an automatic controller for the woollen card as well as carried out much work on the effect of high-temperature dyeing on woollen fibres and the setting of individual fibres and their reactions to changes in relative humidity.

The immensely varied contribution to industrial advance and national welfare which the Department of Scientific and Industrial Research is making, either directly through its own research stations or indirectly through the research associations, or its support of fundamental research at the universities, is amply displayed in this report. Although it is apparent also that in terms of spending power the increased estimates provide for very little real expansion, it is no less clear that every care should be taken to see that those limited resources are spent on objectives that are unlikely to be achieved without government support. The annual report does not supply all the information required for a sound judgment on this aspect; but it goes a long way towards answering some essential questions and indicating others to which reasoned answers should be required.

ANTOINE-FRANÇOIS DE FOURCROY (1755-1809)

By W. A. SMEATON

Northern Polytechnic, London, N.7

ANTOINE-FRANÇOIS DE FOURCROY, who was born in Paris on June 15, 1755, did not achieve lasting fame as an experimental chemist or the founder of a theory; but as a teacher, writer and organizer he was in the first rank, and made a valuable contribution to the progress of science during his lifetime.

His father was a pharmacist, and he was born without the advantages of wealth and influence. As a boy he was not brilliant, and after leaving the Collège d'Harcourt at the age of fourteen, with no definite plans for his career, he worked for several years as a clerk, continuing his education by reading widely in several languages. He became interested in medicine, and was fortunate in attracting the attention of Felix Vicq d'Azyr, the anatomist, who supported and encouraged him while he studied at the Écoles de Médecine. Fourcroy's student years were spent in poverty; he lodged in a garret, and lived by coaching younger students and translating foreign medical works.

While still a student, Fourcroy decided to make his career in scientific research and teaching, rather than medical practice, and he soon showed great ability. His first chemical memoir was read to the Academy of Sciences in 1777, three years before he graduated, and in 1779 he gave his first course of lectures, on chemistry and natural history, in J.-B.-M. Bucquet's laboratory at the Écoles de Médecine. Fourcroy had already established a considerable reputation when Bucquet died in 1780, aged thirty-four; but he was unable to succeed him as professor because the members of the Faculté de Médecine disapproved of his association with Vicq d'Azyr, the secretary of the Société Royale de Médecine, which was in many ways the rival of the Faculté. Fourcroy's progress was not, however, retarded. His chemical lectures continued to be popular, and in

1782 he started an annual course on *materia medica* in his private laboratory near Notre Dame.

P.-J. Macquer, the doyen of French chemists, died in 1784, leaving vacant the chair of chemistry at the Jardin du Roi. The chief two candidates were Fourcroy and C.-L. Berthollet (1748-1822) and, although Berthollet had the influential support of the Duc d'Orléans, Fourcroy was preferred. This was a fortunate choice, for Fourcroy was able to develop his great talent as a teacher, while Berthollet, the better experimental chemist but a poor lecturer, succeeded to Macquer's other post as technical director of the Gobelins dye-works. From 1784 until his death twenty-five years later, Fourcroy lectured at the Jardin du Roi (later called the Jardin des Plantes), and twice the lecture theatre had to be enlarged to accommodate the crowds who were eager to hear him. His knowledge of chemistry was profound, and his lectures included accounts of the latest discoveries. He was a lucid and eloquent speaker, and sometimes drew applause from his audience during a lecture.

In the laboratory, Fourcroy was as active as in the lecture theatre, and he published many memoirs on all branches of chemistry. His study of the action of ammonia on salts led to the discovery of double salts such as magnesium ammonium sulphate; but most of his inorganic research was of little significance. His chief interest was in the examination of organic substances, and in much of this work he benefited from the collaboration of N.-L. Vauquelin (1763-1829), a first-class experimental worker. They analysed many of the liquid and solid parts of plants and animals by extraction with solvents, examined the properties of the products, and in some cases tried to relate their results to those of the older method of analysis by distillation. Later they measured the relative amounts of carbon, hydrogen, oxygen and nitrogen in a number of organic substances, and although little of their work was of lasting value, it was influential at a time when organic chemistry was in its infancy.

Fourcroy was always interested in the application of science to medicine. In his course of *materia medica* he examined the composition and mode of action of the common medicaments, and showed that many were useless or even harmful, and some of his later memoirs dealt with the chemical effects of medicaments on the fluids and tissues of the body. He encouraged others to take a scientific interest in medicine by founding and editing a journal, *La Médecine Éclairée par les Sciences Physiques*.

Even before his election to the Academy of Sciences in 1784, Fourcroy frequently met Lavoisier, and at the end of 1786 he accepted the anti-phlogistic theory and soon became its most vigorous exponent. This was probably his most important contribution to chemistry, for his books were very widely read. In the first edition of his text-book, "Leçons Élémentaires d'Histoire Naturelle et de Chimie", published in 1782, he had favoured Macquer's modification of the phlogiston theory; but in the four editions published between 1786 and 1793, all of which were translated into English, he gave his support to Lavoisier's theory. In 1792 he summarized the new theory and its applications in a small book entitled "Philosophie Chimique", which was reprinted or revised four times and was translated into at least ten languages, and his lectures, which were attended by many foreign students, also contributed largely to the rapid spread of the theory.

Fourcroy supported the French Revolution, and in 1793 he was elected to the Convention. He intervened in few debates; but, while France was at war with most of Europe, he played a leading part in the application of science to such problems as the manufacture of gunpowder and cannons, in the organization of factories, and in the education of engineers and doctors.

In 1797 he was able to resume his scientific work, and found time to write his last and greatest book, "Système des Connaissances Chimiques"; which appeared in eleven volumes in 1801; but his organizing-ability could not be wasted, and Napoleon called him to the Council of State. He became director of public instruction, and was largely responsible for the foundation of the Université Impériale, which comprised the entire educational system of France from the elementary schools to the Institut. Fourcroy confidently expected to become the first 'grand master' of the Université, and he received a severe blow when Louis de Fontanes was given the office. He continued his scientific work and lectures, but the disappointment affected his health; and he died on December 11, 1809, the day that Napoleon made him a Count of the Empire.

BRITISH ASTRONOMERS AT THE TOTAL SOLAR ECLIPSE OF JUNE 20

By PROF. R. O. REDMAN, F.R.S.

THE forthcoming total eclipse of the sun of June 20 is one of rather unusual interest in that the maximum duration of totality on the centre line will exceed 7 min. and is not much below the maximum possible at any eclipse. It will be one of the longest eclipses of this century. The belt of totality starts in the Indian Ocean at sunrise, passes over Ceylon, the Andaman Islands, Thailand, French Indo-China, and the Philippines, and ends at sunset in the Pacific Ocean north of Fiji. Unfortunately, the weather prospects are poor along most of the track; the best chances of a clear sky are in eastern Ceylon, where totality will last for about five minutes. The central hills of the island will give some protection against the south-west monsoon, and mid-eclipse occurs at about 8 a.m. local time, which meteorologically is likely to be as favourable a time of day as any. Weather records from earlier years give a 60 per cent chance for clear sky; but the usual sunshine and cloudiness data are designed primarily for other purposes and give a rather imperfect assessment of the sky for intending eclipse observers, whose work can be ruined by factors not appearing in the records, for example, light cirrus clouds or excessive scintillation. Reports from astronomers already in Ceylon this year suggest that the chances of a really satisfactory sky at totality are well below the 60 per cent quoted.

Astronomers from Britain, France, Germany, Holland, Japan, Switzerland and the United States are intending to observe the eclipse. So far as is known, with the exception of two small groups who are to use aircraft in Indo-China and Fiji respectively, all are going to Ceylon and will be stationed at a number of sites in and near Polonnaruwa. In this article we shall confine ourselves to an outline of the British plans.

OBITUARIES

Dr. Otto Rosenheim, F.R.S.

It is less than a year since the last total eclipse, in Sweden, where British observers were among the minority who had a sufficiently clear sky to complete most of their programmes of work successfully. This year's work from the ground will consist mainly of a repetition of some of the 1954 observations, with improvements in instruments and procedure suggested by the experience gained in Sweden. Last year, Dr. H. von Klüber (Cambridge) and Dr. A. H. Jarrett (St. Andrews) succeeded in the technically difficult feat of photographing the corona through a Fabry-Perot interferometer using the light of the green 5303 Å. line. Measurement of the fringes has given a distribution over the inner corona of the line width and hence of the kinetic temperature, and this year the experiment will be repeated, using a larger solar image and photographing in the light of the red 6374 Å. line, as well as in 5303 Å.

Prof. C. W. Allen and Dr. E. W. Foster (London University Observatory) will again be engaged in photometry and spectroscopy of the corona with the general purpose of testing theoretical models of the electron K corona and the dust F corona. The special feature of the camera to be used for photometry is an occulting disk mounted on a tower at some distance from the lens. Its purpose is to equalize the intensity of the inner and outer corona, so that both may be satisfactorily photographed in one exposure. Their second instrument, a fast spectrograph, is also designed to record the outer and inner corona simultaneously on one photograph. An absolute photometric standardization will be provided and the polarization of the corona also will be measured.

Prof. E. Finlay-Freundlich (St. Andrews) had intended to go to Ceylon to co-operate with astronomers from the Potsdam Observatory in measuring the Einstein displacement in the star field surrounding the sun. Owing to ill-health, he has been prevented from travelling; but the Potsdam observers and equipment are in Ceylon, and will be assisted by Dr. von Klüber, who worked on this problem with Prof. Freundlich at the 1929 eclipse in Siam.

Finally, Dr. D. E. Blackwell (Cambridge), who in 1954 succeeded in photographing the outer corona from an aircraft flying at 30,000 ft. and thence in obtaining good photometric measurements out to a much greater distance from the sun than ever reached before, is this year to attempt to photograph the outer corona and zodiacal light after the eclipsed sun has set. The dust which produces the F component of the corona is believed to be closely associated with that giving rise to the zodiacal light, and the problem is to bridge the existing large gap in photometric measures between the two. The ordinary zodiacal light cannot be observed with the eclipsed sun above the horizon, as the sky is then much brighter than often supposed, because of light scattered in from the sides of the moon's shadow as a kind of dawn. The device of working with the eclipsed sun below the horizon has been tried a few times by other observers, but so far without success. Dr. Blackwell will work at about 10,000 ft. over the open Pacific Ocean, in a Sunderland flying boat based on Fiji. The aircraft will be provided by courtesy of the New Zealand Air Force, by arrangement with the Defence Services Research Facilities Committee of the Royal Society.

As at other recent eclipses, all British observers are working with the support of the Joint Permanent Eclipse Committee of the Royal Society and Royal Astronomical Society.

The announcement of the death on May 7 of Otto Rosenheim at the age of eighty-four will recall a friendly figure often seen at meetings of scientific societies in London, to many of which he was a notable contributor of highly original observations.

Rosenheim was born in Germany, where he took his Ph.D. degree at Würzburg, working under Tafel in Emil Fischer's laboratory. For part of the course he went to Bonn, and on completion of his degree to Geneva to work with Graebe. In 1895, through the mediation of Perkin, he went to Manchester for further study, and in 1901 joined Tunnicliffe in Halliburton's department at King's College, London, as research student in pharmacological chemistry; he was made lecturer in 1904, and on Tunnicliffe's departure became assistant professor of physiology. Later he became reader in biochemistry in the University of London—an appointment he relinquished in 1920.

After retiring for a few years from official duties, he went as a voluntary worker to the National Institute for Medical Research at Hampstead in 1925, and so began a second period of research which lasted for another twenty years.

In the early period, during his association with Tunnicliffe, after some preliminary work on uric acid and the quadriurates, he investigated the toxicity of beer due to the presence of selenium, and also determined the proportion of formaldehyde in milk and food which would have no effect on healthy children. In after years, he often had resort to feeding experiments in intricate problems of sterol metabolism.

With Locke he took part in the classical investigation in which a new perfusion method was devised for the mammalian heart using dextrose in oxygenated Ringer solution; but his outstanding achievement at King's College was his arduous work on the constituents of the brain. In this he was ably assisted by Mary Christine Tebb, whom he later married. They laid the bog of protagon, around which unseemly controversy had raged. Thudichum, of whom Rosenheim was an ardent admirer, had shown in 1874 that protagon was a mixture; but Liebreich, Gamgee, Blankenhorn and Cramer believed it to be a molecular entity. Rosenheim and Miss Tebb demonstrated how dried brain treated mildly with solvents could be separated into free cholesterol, two phosphorus-free galactosides (phrenosin and kersin) and a phosphorus-containing residue of sphingomyelin. The structures advanced by Rosenheim for phrenosin and kersin are close to those now accepted.

In 1909 Rosenheim examined extracts of placenta, showing that if there was no putrefaction there was no pressor effect. Lixon and Tayler had claimed the contrary. Incidentally, Rosenheim identified tyramine as a product of putrefaction.

During his period of temporary retirement, Rosenheim, who was an enthusiastic rock-gardener, interested himself in some problems posed by the pigments of edelweiss and young vine leaves.

On coming to the National Institute for Medical Research in 1925, Rosenheim brought with him the problem of spermine phosphate, the conditions for the isolation of which he and his wife had already worked out. With Dudley and later with Starling's

preparative help, they elucidated the distribution and constitution of spermine and spermidine, two bases of unknown function present in mammalian tissues and fluids.

In 1925 Drummond, Rosenheim and Coward had shown that the precursor of the antirachitic substance found in foodstuffs on ultra-violet irradiation was in the fats, and in fact in the sterol fraction. With Webster, who in Leonard Hill's department had already devised a reliable technique for the testing of antirachitic substances on rats, he concentrated on the problem of the activatable sterol and arrived at the important discovery that the so-called pro-vitamin was ergosterol. This led, in the hands of Callow, Bourdillon and their collaborators, to the actual isolation of vitamin D.

In the vitamin A field, too, Rosenheim and Drummond found that the vitamin A content of cod liver oil was approximately proportional to the colour intensity produced by addition of arsenic trichloride, an observation which facilitated further advances.

In 1932 Rosenheim and I were fortunate in resolving the impasse reached in the problem of the structure of the sterols and bile acids by suggesting a revolutionary modification of the structures hitherto proposed. Great advances have flowed from the new formulæ, not only in the sterols and bile acids but also in the heart poisons, sex-hormones and constituents of the adrenals.

Rosenheim's contributions to medical science were many. He was a born investigator, meticulous and thorough in all he attempted. The uses to which he put colour reactions and mixed solvents in purification procedures were fascinating and entrancing. He was full of encouragement for the young worker. His remarkable memory and his encyclopædic knowledge were ever available and often called upon by his many colleagues. For many years he was a valued member of the Accessory Food Factors Committee of the Medical Research Council. He was a Fellow of the Linnean Society and was elected a Fellow of the Royal Society in 1927.

HAROLD KING

Dr. R. W. Boyle

THE sudden death of Robert William Boyle in London on April 18, at the age of seventy-one, has removed one of the last of that small band of pioneers who were responsible for establishing in Canada the importance of research during the early years of the present century. Born in Carbonear, Newfoundland, on October 2, 1883, the son of Dr. Albert D. Boyle and Sophie Madelock Boyle, he received his early education there and in St. John's College, from which he graduated with the award of the Newfoundland Government Jubilee Scholarship. He then entered McGill University, where he studied electrical engineering, graduating in 1905; but, stimulated by the influence of Rutherford, then Macdonald professor at McGill, he turned to a career in physics. He was awarded in 1909 the first Ph.D. granted by McGill and in the same year was chosen an 1851 Exhibition scholar, proceeding to Manchester, where he carried out research under Rutherford on the properties of radium and thorium emanations. Returning to McGill in 1911, he taught physics and mathematics, and in 1912, on the establishment of the University of Alberta, was appointed head of the Department of Physics at the new provincial institution. With his

drive and enthusiasm, he established an excellent department, both for instruction and emphasis on research.

Soon after the outbreak of the First World War, Boyle joined the staff of the Board of Invention and Research, later known as the Antisubmarine Division of the Admiralty. During this period, he developed the method of submarine detection using ultrasonics produced by oscillations of quartz crystals due to their piezoelectric properties. This was a very difficult investigation at a time when electronic amplifiers were not yet available; and when the simple triode tubes eventually were obtained, he established by his drive and vision the success of what later became known as the 'Asdic'. On returning to Alberta in 1919, he continued research on ultrasonics with a small band of enthusiastic research students, making numerous fundamental measurements in this field of physics. His appointment as dean of the Faculty of Applied Science in 1921 extended his influence on research to other fields, creating in western Canada an oasis of scientific interest in original investigation that has continued ever since. The establishment of the National Research Laboratories in Ottawa required a director with energy and vision for the Division of Physics and Electrical Engineering, and Boyle was appointed to fill this new post in 1929, which position he occupied until his retirement in 1948. During this period, his Division made notable contributions to Canadian industry and, especially during the Second World War, was responsible for the major development in radar and various other devices which the Council contributed to the war effort.

Boyle was a lovable character, an interesting and vivid conversationalist, and a kindly loyal friend to all his colleagues. Travel and fishing were his particular hobbies, which occupied his period of retirement. We looked forward to his periodic return to Canada from his travels, for we were assured of a most enjoyable evening hearing of his adventures in picturesque and lively descriptions of places and people he saw and met. He will be greatly missed by his many friends in Canada and abroad.

He received many honours. Elected to the Royal Society of Canada in 1921, he was president of Section III, 1924-25, received the Flavelle Medal in 1940, and was made LL.D. by the University of Alberta in 1933. He was a Fellow of the American Physical Society, the Acoustical Society, and a member of numerous engineering societies. He is survived by two sisters, Mrs. Mary E. Watts and Mrs. Margaret B. Horton, of Billerica, Mass., and three brothers, Dr. Hubert Boyle of New Bedford, Mass., George Boyle of Grand Falls, Newfoundland, and Albert S. Boyle of Edmonton; he never married.

D. A. KEYS

Mr. F. G. Simpson, C.B.E.

FRANK GERALD SIMPSON, who died on May 14, devoted a working life of fifty years to the study of Hadrian's Wall. By training an engineer, he was fired by the possibility of scientific study which the methodically designed Roman works seemed to offer to archaeological investigation. His excavations, undertaken with a precision and clarity which surpassed and surprised all professional contemporaries, reduced the apparent confusion that often attends new discoveries to problems which seemed either simple or insoluble; for they revealed that

the evolution of this most elaborate of Roman frontiers was very much more complicated than had been supposed. But in thirty years, despite the interruption of the First World War, order had been achieved: an apparently ineluctable tangle of evidence was defined, sorted and clarified, and the major problems of the relationship of Wall and Vallum, or of the many structures on the Wall itself, were solved finally and completely.

In achieving the task, Simpson not only evolved his own impeccable technique in excavation, but was among the pioneers who made of stratified pottery an exact instrument for chronology. His classification of this material, finally established in 1929, is basic for Roman studies in northern Britain and set a standard in a far wider field. His talents were early recognized by an honorary fellowship of the Society

of Antiquaries of Scotland, and were presently enlisted by the University of Durham, in which he was an honorary M.A. and director of field studies during 1924-30; then, having gathered about him the nucleus of the archaeological school, he made way for more regular teaching than he himself desired to undertake.

Simpson was for many years director of the Cumberland Excavation Committee and an active member of the North of England Excavation Committee; also president of the Cumberland and Westmorland Archaeological Society and a vice-president of the Society of Antiquaries of Newcastle upon Tyne. The national significance of his work was fitly recognized in 1949, when he was appointed C.B.E., on the occasion of the Centenary Pilgrimage of the Roman Wall.

I. A. RICHMOND

NEWS and VIEWS

Botany at Bristol:

Prof. M. Skene

PROF. MACGREGOR SKENE is to retire from the Melville Wills chair of botany in the University of Bristol at the end of this session. Prof. Skene was educated at Robert Gordon's College and the University of Aberdeen, where he studied botany under J. W. H. Trail and zoology under J. Arthur Thomson. After graduating he spent more than two years in France and Germany working under L. Kny, Erwin Baur, L. Jost and C. Flahault. He returned to Aberdeen as assistant with the task of introducing plant physiology into a course until then largely systematic. During the First World War he served for four years with the Royal Field Artillery (T.F.). After a further period in Aberdeen he was appointed lecturer in the University of Bristol in 1926 and reader in 1930. In 1935 he succeeded O. V. Darbishire in the Melville Wills chair. He took part in the planning of a new wing for the biological departments, which was completed just before the outbreak of the Second World War and made possible the accommodation of the students and staff of King's College, London. Since the War he has been a member of the Developments Committee of the University and chairman of the Committee on University Grounds and Gardens. Apart from a number of original papers on physiological topics, his publications include "The Biology of Flowering Plants" and "A Flower Book for the Pocket".

Prof. E. W. Yemm

DR. EDWARD W. YEMM, reader in botany in the University, has been appointed to succeed Prof. Skene. Dr. Yemm was educated at Wyggeston School and Queen's College, Oxford. He graduated in 1931 with first-class honours in botany and was awarded the Christopher Welch biological scholarship. In 1935 he was elected to a research fellowship of Queen's College. He was for some years demonstrator in the Department of Botany of the University of Oxford, and during part of the time was in charge of the physiological research laboratory. In 1938 he was appointed to a lectureship in the University of Bristol. During the War he was at first concerned with radar work in the R.A.O.C. and later was engaged on penicillin production. After his return to Bristol he was appointed reader in 1951. For some

months in 1954 he visited the United States as a Special Rockefeller Fellow. He has recently taken an active part in building up the honours school of biological chemistry. Dr. Yemm's chief research interests are physiological and ecological. His work on the nitrogen metabolism of seedlings is well known, and he has published a long series of papers on this and on related topics. He is also engaged in work on stomatal mechanisms and on the ecology of dunes.

Physics in the Durham Colleges:

Prof. J. E. P. Wagstaff

PROF. J. E. P. WAGSTAFF, who retires under the age limit at the end of the present session, has held the chair of physics in the Durham Colleges since its institution in 1924. After taking a double first in the Mathematical and Natural Sciences Triposes at Cambridge, he served as a research physicist during the First World War in the Research Department of the Royal Arsenal, Woolwich. In 1920 he was appointed to a lectureship in physics in the University of Leeds, which he held until he moved to Durham. Here he faced the task of building up a new department with little assistance—only one lecturer at first—and distinctly limited resources. His success may be indicated by the increase in the number of honours students from two, in his first year, to about forty in recent years. The lecturing staff has correspondingly grown to the present number of five; successive additions to accommodation have also been made, with the result that the teaching and research facilities of the Department are now in all respects admirable. Prof. Wagstaff has always taken a great interest in teaching, and his lucid and interesting lectures, illustrated wherever possible by demonstrations, have been greatly appreciated by his students. They also owe him much for his kindly interest in them as persons, and for his constant solicitude for their welfare, maintained wherever possible after their departure from the University. Although his former students are to be found occupying all types of appointment open to the physicist, it may be said that he has always regarded the profession of teaching as of especial importance, and that he has spared no pains to provide for that profession a supply of well-trained and well-balanced graduates.

Dr. G. D. Rochester

DR. G. D. ROCHESTER, who is to succeed Prof. Wagstaff, is a Durham graduate, having taken his degree, with first-class honours in physics, at Armstrong College, Newcastle upon Tyne, in 1930. After spending some four years in research on band spectra with Prof. W. E. Curtis, he conducted further research in the same field at Stockholm and at Berkeley, California. He then took up an appointment as assistant lecturer in physics in the University of Manchester, where he is now reader. Although by the time he went to Manchester he had achieved a considerable reputation in spectroscopy, he abandoned this for the field of cosmic rays. In this he was no less successful, and in 1947 he discovered, with C. C. Butler, two new types of heavy, unstable, sub-nuclear particles, and thus opened up a field of study which is being energetically pursued by experimental and theoretical physicists all over the world. He has published many papers on this and other topics covering various aspects of cosmic rays. In addition to his active prosecution of research, Dr. Rochester has taken a very full share in administrative and other work at Manchester. He has acted as tutor to science students, secretary to the Ph.D. Committee, treasurer of Staff House, and has served the University in many other capacities. He has also served on a number of government and professional committees, and is at present scientific adviser in civil defence for the North-West Region of England.

Electrical Engineering in Sheffield:

Prof. A. L. Cullen

DR. A. L. CULLEN, who has been appointed to the newly created chair of electrical engineering in the University of Sheffield, was born in 1920. As an undergraduate, he studied at the Imperial College of Science and Technology, London, and took his B.Sc. (Eng.) in 1940. He immediately joined the staff of the Radio Department, Royal Aircraft Establishment, Farnborough, Hants, where he was engaged on war work until 1946. During that period he made important contributions to microwave radar techniques, and carried out experiments that led to valuable new designs of waveguide aerials. In May 1946 Dr. Cullen became a lecturer in the Electrical Engineering Department at University College, London, and he is now a reader in the Department. Side by side with his teaching duties he has given much attention to research, and has published many important papers recording the results of his work. In particular, he has developed a new type of instrument for the measurement of microwave power by radiation pressure, and this is likely to become a standard of reference for this purpose at the National Physical Laboratory. He was elected a chartered electrical engineer in 1949, and obtained the Ph.D. degree in 1951. For scientific papers published in the *Proceedings of the Institution of Electrical Engineers* he was awarded the Kelvin Premium in 1952, an Extra Premium in 1953 and a Radio Section Premium in 1954. He is well known outside his own College as a lecturer, and also he is often consulted on scientific matters by government research establishments and by industrial undertakings.

Metallurgy as Technology and Science

DURING recent years there is close touch with metallurgical thought and development have become increasingly conscious that metallurgy has been

growing not only into a technology of ever-increasing importance but also into a science in its own right. It was therefore fitting that, in taking office as president of the Institution of Metallurgists at the annual general meeting held on May 25, Prof. F. C. Thompson should choose this as his principal theme. On the technological side he stressed the extent to which progress in other fields of science and engineering is dependent upon the ability of the metallurgist to provide alloys with special properties. To meet these needs the metallurgist has developed a wide range of new alloys—alloys with properties of strength, creep resistance, hardness, or corrosion resistance, or with magnetic characteristics which would have seemed quite impossible of attainment even thirty years ago. These advances on the technological side have been accompanied by a corresponding increase in fundamental knowledge of metals and alloys, and this has contributed in no small measure to our understanding of the solid state—in particular, of the crystalline state. As two examples of the way in which other sciences have benefited from metallurgical work, Prof. Thompson cited the light thrown on general problems of rheology by studies of the deformation and flow of metals, and the enrichment of inorganic chemistry by the work of Dr. W. Humé-Rothery and his school in elucidating many of the fundamental principles governing the interaction of atoms in alloy formation.

In his concluding remarks, Prof. Thompson referred to the continued rapid growth of the Institution and to the high standard that had come to be associated with its examinations. The Institution has rightly required that its members should have breadth of knowledge and experience; but the time may be coming when consideration should be given to the establishment of a further qualification awarded after examination to those who, having already received a broad training, have made a specialized study of a particular aspect of metallurgy. Emphasizing that these ideas were purely personal, Prof. Thompson said that such a qualification might have many beneficial effects. Associates might be encouraged to continue study until they could hope to qualify as Fellows, and in consequence the best of the colleges of technology in Britain might arrange still more advanced courses of study.

Leonard Dobbin Memorial Lecture of the Alembic Club

THE Alembic Club was founded by the junior staff of the Chemistry Department of the University of Edinburgh in 1889. It is famous for its reprints of classical chemical investigations, a series of publications known as the Alembic Club Reprints, instigated mainly by Dr. Leonard Dobbin, secretary of the Club for fifty-seven years. After the death of Dr. Dobbin in 1952, the surviving members requested the Council of the Royal Society of Edinburgh to accept the entire assets of the Club and the responsibility for the continuance and extension of its series of reprints. This offer was accepted, and it was decided that the first Alembic Club Lecture under the auspices of the Society should be formally entitled the Leonard Dobbin Memorial Lecture. This Lecture was delivered by Prof. James Kendall, professor of chemistry in the University of Edinburgh, on June 6, and his subject was "Michael Faraday". Prof. Kendall remarked that Faraday's pioneer work on the liquefaction of gases is recorded in full in Alembic Club Reprint No. 12. His fundamental researches on

electricity and magnetism are well known as the basis of all practical developments in that field during the past century. In 1844, Faraday was invited to accept the chair of chemistry at the University of Edinburgh. His loyalty to the Royal Institution, however, led him to refuse; money meant nothing to him—the advancement of science was his sole objective.

British Nuclear Energy Conference

In the light of recent rapid developments in the technology of nuclear energy, and the increasing demand for a common ground between scientists and engineers where these developments can be discussed, an organization has been formed by the Institutions of Civil, Mechanical, Electrical, and Chemical Engineers, and the Institute of Physics, to satisfy this need. This will be known as the British Nuclear Energy Conference, and its affairs will be managed by a board consisting of three representatives from each of these societies. The chairman is Sir Christopher Hinton, and the secretary Mr. Alexander McDonald (secretary of the Institution of Civil Engineers, Great George Street, London, S.W.1). The five societies will arrange for the presentation of papers dealing with nuclear energy subjects, and all members of the societies will be able to attend and take part in the discussions. The Conference will publish a journal about four times a year containing records of the papers, discussions, symposia and conferences conducted by the Board. This journal will be offered for sale. The Board proposes to hold its inaugural meeting in the autumn, at which a symposium of lectures will be delivered on the technology of nuclear energy and its applications. The Board proposes to promote national and international conferences from time to time, and to arrange for British participation in international meetings. The expenses of the Conference will be met by the societies, although it is expected to be self-supporting once it is fully established.

Colonial Geology in the British Commonwealth

THE quarterly bulletin of the Colonial Geological Surveys, *Colonial Geology and Mineral Resources* (London: H.M.S.O.; 7s. 6d. a number), is now well into its fifth volume. Since its inception in 1950, its publication has been an outstanding success, and in many parts of the world it must have become one of the most welcome of geological journals. Important contributions to the earlier volumes include up-to-date accounts of the geology and mineral resources of Northern Rhodesia, Sierra Leone, Nigeria, Somaliland, Jamaica, Mauritius, Trinidad and St. Helena; and of specific mineral deposits such as those of lead-zinc-vanadium at Broken Hill (Northern Rhodesia), manganese in the Gold Coast, bauxite in Jamaica, wolfram in Uganda, and coal in Bechuanaland. A regular feature of great scientific value as well as of personal interest is devoted to reports on the progress of the various Colonial Geological Surveys. No. 1 of the current volume (March 1955; pp. 126) is notable in containing a very full and well-documented report on African geochronology, which indicates that seven Pre-Cambrian orogenic cycles have now been dated in Africa, carrying geological history back at least three thousand million years. A cautiously optimistic account of the industrial possibilities of mineral wealth in Tanganyika is accompanied by geological and mineral maps of the high quality that character-

izes all the illustrations of the bulletin. No. 2 (May 1955; pp. 128) contains articles on the Upper Cretaceous Mollusca of Nigeria; on the effects of heat and hydrochloric acid on cassiterite, columbite and other economic Nigerian minerals; and on the geology of a remarkable dome-like structure of concentric shells of granitic and amphibolitic rocks recently discovered on the western flank of the Sula Mountains in Sierra Leone. Besides the reports mentioned above, other regular features include notes on matters of current interest, abstracts, bibliographies, reviews and mineral statistics.

Coal Gasification in Australia

In his Masson Memorial Lecture at the meeting of the Australian and New Zealand Association for the Advancement of Science at Canberra on January 15, 1954, Dr. P. S. Andrews gave a full account of the Federal project for the pressure gasification of non-coking coals for the combined purpose of town's gas and the production of synthetic liquid fuel. Work on the gasification of brown coal in Victoria was commenced in 1931 by the technical staff of the Metropolitan Gas Co.; but the present project was based on research carried out in Germany and the United States and elsewhere. Contracts for the plant for the project were placed in 1951, and it was expected that manufacture of gas would commence in 1951 with an output of 1E million cubic feet per day, or nearly half the present requirements of Melbourne. Three hundred and seventy acres had been purchased by the Gas and Fuel Corporation of Victoria, some ninety-six miles from Melbourne, and, when completed, the initial plant would comprise six Lurgi pressure generators, two boilers fired by brown coal, with an evaporative capacity of 55,000 lb. per hr. each, and two Linde-Frankl oxygen units each capable of liquefying 500,000 cu. ft. of air per hr. for oxygen production. In addition to gas, 1 million gallons of tar and 300,000 gallons of benzole would be recovered per annum. The gas would be conveyed in an 18-in. welded steel pipe for 7.4 miles to the terminal station, where pressure would be reduced to 25 lb., and it would enter the present reticulation system at three points about twenty-two miles from the terminal station. Eventually the gas would be pumped to the principal country centres of Victoria, and it was expected that ultimately the gas industry would adopt the method in all the Australian States. Further research is proceeding into properties and reactivities of non-coking coals, into the interchangeability of gas from black coal and brown coal, and the dehydration, rehumidification and odorization of the gas. By 1976 an output of 60,000 million cu. ft. of 450 B.Th.U. gas was projected, with 22 million gallons of petrol and 20 million gallons of diesel and fuel oil, and recoveries from the gas of 13 million gallons of tar, 5 million gallons of high-octane benzole motor spirit and 1.5 million gallons of naphtha.

Large-scale Experiment in Weather Modification in the United States

NEW YORK UNIVERSITY has recently reported on an extensive cloud-seeding experiment, "Project Seud", carried out along the eastern coast of the United States during 1953-54 and sponsored by the Office of Naval Research. During January-April 1953 and December 1953-April 1954, aircraft dropped 30 tons of "dry ice" into cyclonic storms lying between Florida and Massachusetts and, in addition, 250 lb. of silver iodide was vaporized from

seventeen ground generators located between Florida and New York. The object of the trials was to determine whether cloud-seeding could change the intensity or direction of developing storms. Thirty-seven meteorological situations were selected, and seeding was carried out on eighteen occasions, the seeded and non-seeded cases being selected on a random basis and then paired. The non-seeding occasions were used as control situations. During the first period of operations, three aircraft flew along parallel tracks a hundred miles apart each dispensing 1,000 lb. of crushed 'dry ice' at the rate of 1 lb./mile; during the second period, 2,500 lb. was dispensed at 5 lb./mile along 500-mile tracks. The silver iodide generators were operated for twelve-hour periods. In trying to detect possible effects caused by the seeding, particular attention was paid to pressure changes; secondary factors were precipitation, cloud formation and wind direction. The report adds that the trials showed no evidence that statistically significant large-scale effects were caused by the seeding.

Folia Biologica: New Czechoslovak Journal

THE first number of a new bi-monthly journal, *Folia Biologica*, which is the international edition of *Československá Biologie*, has recently appeared, published in Prague (from 'Artia', Smečky 30, Praha 2; 60 Kčs. a year, or 10 Kčs. an issue). The first article, on the significance of phylogenetic kinship in immunological approximation during embryogenesis, by M. Hašek and T. Hrabá, is written in English and has a summary in Russian. The authors experimentally connected the extra-embryonic circulatory systems of duck and hen chicks, turkey and hen chicks, and pheasant and hen chicks, and studied the immunological results. The second article, on the growth of tumour cells in synthetic media, by M. Rychlíková and H. Keilová, is written in Russian with a summary in English and is illustrated by photographs. Two other articles are also in Russian with summaries in English: the vitality of cell fragments of yeasts—(1) plasmatic droplets of yeasts, by O. Nečas; and a method for evaluating the effect of ionizing radiation on micro-organisms (the hypotrichous ciliate protozoan *Tetrahymena geleii*), by A. Lengerová. Three articles are in Russian with summaries in German: the splitting of starch by the enzymatic complex of soils (J. Drobník); the relationship of enzymatic inversion in the soil to some microbiological tests (J. Drobník and J. Seifert); and the composition and changes in humus in some forest soils (Z. Ambrož). The number ends with a note in Russian, with a summary in English, on double-staining with acid stains in plant tissue, by I. Hřšel.

Science Tools: New Swedish Journal

THE firm of LKB-Produkter Fabriksaktiebolag, Stockholm, has begun issuing a new journal, *Science Tools*, which is published in English, about once every three months, and is intended to be a link between the instrument manufacturer and the laboratory research worker. The journal contains articles by well-known scientific workers dealing with modern equipment used in physical chemistry and nuclear science. In the first three numbers which have already appeared there are a number of articles of wide appeal: for example, E. Valmet and H. Svensson, on problems connected with paper electrophoresis;

H. Svensson and B. Olhagen, on electrophoresis serum and plasma in free solution without prior dialysis; and L. Hagdahl, on the use of coupled columns in chromatography. The journal is issued free to laboratory workers, who if they work in Great Britain should apply in the first place to Huddell Merchandizing Corporation, Ltd., Charter House, 52 Gloucester Place, London, W.1.

Early Carboniferous Floras

A MONOGRAPH by W. J. Jongmans on "The Carboniferous Flora of Peru" (*Bull. Brit. Mus. (Nat. Hist.), Geology*, 2, No. 5; pp. 36+10 plates; 1954, 15s.) emphasizes anew the wide distribution of flora of comparatively uniform aspect in the early Carboniferous in contrast with the differentiation of well-marked floral provinces in later Carboniferous time. Jongmans confirms as Lower Carboniferous the age of certain floras on the west coast of Peru which have sometimes been assigned to the later Carboniferous; he uses new collections of these compression floras to corroborate earlier results of other workers. Among the genera represented are *Rhacopteris*, *Triphylopteris*, *Cyclostigma* and *Lepidodendropsis*, and a critical review is given of the distribution of the latter little-known genus, of which two new species are described. The general aspect of the Peruvian floras is similar to that of *Rhacopteris* and *Lepidodendropsis* floras of other Lower Carboniferous localities. *Lepidodendropsis* is occasionally absent, as in Australia, from the *Rhacopteris* floras, and also occurs sometimes in strata usually assigned to the Upper Devonian, as in the Donetz basin. Indeed Jongmans suggests that the *Rhacopteris*-*Lepidodendropsis* floras may represent a transition between *Archaeopteris*-*Cyclostigma* floras of the true Devonian and later floras of the Mississippian.

The difficulty of drawing any clear-cut line between Upper Devonian and Lower Carboniferous with respect to the plants has recently been further illustrated by 'transition' floras from rich collections of petrified plants in the Devonian-Mississippian black shales of the Upper New Albany formation of Kentucky, Tennessee and Indiana. These plants comprise some twenty-nine genera, many representing stem and leaf axes, which have been reviewed and redescribed by A. T. Cross and J. H. Hoskins (*J. Paleontol.*, 25, No. 713 (1951), and C.R. 3rd Cong. Avanc. Étud. Stratigr. Carbonifère, 1, 113 (1952) (Heerlen)). So far, no connexions between species of the compression floras and the petrified floras have been demonstrated, though the circumstances of their distribution suggest that some relationships may exist; but further evidence may well be forthcoming, for example, from the investigation of such floras as those described by Walton from the base of the Lower Carboniferous in the Kilpatrick Hills, Scotland, where the plant-remains are partly petrified and partly compressed. Jongmans's review focuses fresh interest on those horizons where critical stages in the evolution of the rich later Carboniferous flora and in particular of the seed plants, may be followed up.

Rain and Plant Dispersal Mechanisms

H. J. BRODIE (*Canad. J. Bot.*, 33, 2, 156; 1955) has given an account of a number of seed dispersal mechanisms of the 'springboard' type which are operated by raindrops. Most of the older accounts of seed dispersal in such genera as *Salvia* leave the impression that almost any kind of blow will set a

the discharge mechanism; it was not realized that such springboard structures are chiefly, if not exclusively, operated by raindrops. The calyx tube and pedicel of *Salvia lyrata* serve as a springboard mechanism from which the nutlets are thrown out violently when raindrops land on the distal part of the upper lip of the calyx. The force of the striking raindrop depresses the springy pedicel and, when this returns to its normal position, the nutlets are thrown from the calyx tube as a swimmer is projected from a diving board. The nutlets become surrounded by a coat of extruded mucilage as soon as they are wetted. *Ocimum basilicum* and other members of the Labiatae have similar springboard dispersal mechanisms which are operated by raindrops. The plantlets or gemmæ of the succulent plant *Kalanchoë tubiflora* develop on narrow outgrowths from the parent leaf. These attachments serve as springboards from which the plantlets are violently discharged by raindrops. The plantlets are cup-shaped and are very effective in catching raindrops. The splashing action of raindrops may sometimes be an important agency effecting the pollination of certain cup-shaped flowers such as those of *Ranunculus*. About eighteen rain-operated dispersal mechanisms are now recognized. These are distributed among four of the major groups of the plant kingdom, and it is probable that some examples will be found in all phyla of land plants.

United States National Museum : Annual Report

THE annual report for the year ended June 30, 1954, of the United States National Museum (pp. 100; Washington, D.C.: Smithsonian Institution, 1954) provides ample evidence of statesmanlike vision and executive activity at this great institution. Thus, the modernization of the hall devoted to Latin American archaeology was completed and now exhibits man's cultural development from his earliest known beginnings in Latin America to the high civilizations of the Inca, Aztec and Maya. The cases show the advance of various cultures from the simple hunting, fishing and gathering level of existence to the highly advanced societies practising well-developed agriculture with complex social and political organizations and skilled technologies. The scale of the activities of this Museum may be realized from the fact that during the year nearly 650,000 individual specimens were added to the collections, which now total more than thirty-two million.

Animal Production from Grass : Meeting in Reading

THE European Association for Animal Production is holding its fifth study meeting in Reading during July 9-13. The subject of the meeting will be "Animal Production from Grass"; Prof. M. M. Cooper, of King's College (University of Durham), Newcastle upon Tyne, will give a paper on animal management for intensive production from grass, and there will also be a paper by two Dutch contributors. About 100-150 delegates are expected. Before the meeting there will be a visit to the Royal Show at Nottingham and to the Research Farm at Thurgarton, Nottingham, of Boots Pure Drug Co., Ltd. Visits will also be made to the Grassland Research Station, Hurley, the National Institute for Research in Dairying, Shinfield, and to Mr. Maurice Passmore's farm in Warwickshire. The arrangements for the meeting are being made by the British Society of Animal Production, which is the United Kingdom member of the European Association. Further information can be obtained from the secretary-

treasurer of the Society, J. P. Maule, Commonwealth Bureau of Animal Breeding and Genetics, King's Buildings, West Mains Road, Edinburgh 9.

Colonial Service : Recent Appointments

THE following appointments have recently been made in the Colonial Service: A. P. A. Forbes (chief agricultural officer, Nyasaland), deputy director of agriculture, Tanganyika; C. R. Groves (assistant director of agriculture, Bermuda), director of agriculture, Bermuda; J. R. P. Soper (deputy director of agriculture, Tanganyika), director of agriculture, Tanganyika; E. Williams (assistant director of agriculture, Nyasaland), deputy director of agriculture, Nyasaland; K. E. Woodcock (field officer, Insecticide Research Department, Tanganyika), field officer, Tsetse Control Department, Uganda; J. O. Meehan, assistant conservator of forests, Northern Rhodesia; R. Pickering, geologist, Tanganyika; J. R. Cutler, scientific officer, West African Stored Products Research Institute, Nigeria; M. J. Henigan, veterinary officer, Singapore; C. H. Brown, senior principal scientific officer, British Guiana and British Honduras.

Announcements

PROF. SERGEI BEINSTEIN, formerly director of the Institute of Mathematical Sciences, Kharkov, and Prof. Bernard Houssay, director of the Institute of Experimental Biology and Medicine, Buenos Aires, have been elected foreign associates of the Paris Academy of Sciences.

THE following appointments have been made in the Imperial College of Science and Technology, London: Dr. J. H. Argyris, reader in the theory of aeronautical structures, to the University chair of aeronautical structures; and Dr. G. D. Hobson, lecturer in oil technology, to the University readership in oil technology.

THE new Water Pollution Research Laboratory at Stevenage of the Department of Scientific and Industrial Research will be opened by the Lord President of the Council on June 20 at 3.30 p.m.

THE Royal Meteorological Society will hold a two-day meeting during July 21-23 in Ashburne Hall, University of Manchester, which will be open, without entrance fee, to non-members. The meeting will take the form of two symposia on "Some Aspects of Turbulence in the Atmosphere" and on oceanographic topics, respectively. Bookings for accommodation, excursion, etc., should be made not later than July 7; further information and reservation forms are available from the Assistant Secretary of the Society, 49 Cromwell Road, London, S.W.7.

THE British Association's Division for Social and International Relations of Science will be holding a conference on "Land Use" during July 15-16 in the Washington Singer Hall, University College of the South-West, Exeter, under the chairmanship of Mr. P. Ritchie Calder. The topics to be discussed will be: the allocation of land—the administrative functions of central and local government; the need of land—agriculture and forestry; the preservation of amenities in relation to land use; the needs of the Armed Forces for land; the need of land for mineral exploitation—land restoration; and the need of land for urban and industrial development. Further information can be obtained from the Secretary, British Association, Burlington House, London, W.1.

NEW LABORATORIES FOR INORGANIC AND PHYSICAL CHEMISTRY IN THE UNIVERSITY OF LIVERPOOL

THE new Laboratories of Inorganic and Physical Chemistry in the University of Liverpool were opened by H.R.H. the Duke of Edinburgh on May 11. The building is one of the first to be completed according to the plan and in the area set aside for the development of the University. The laboratories, of a total floor area of 88,000 sq. ft., provide for the teaching of both inorganic and physical chemistry at the various levels of training required for students specializing in chemistry and for those students who study chemistry as a preparation for specialization in medicine, dentistry, veterinary science, engineering and metallurgy. The laboratories provide places for some four hundred undergraduates at any one time, and for forty to fifty research workers.

The building (Fig. 1) comprises two large wings, each of two stories, with a connecting spine of three stories from pavement-level. The latter contains specialized laboratories and research, staff and cloak rooms. In each of the wings are located two large laboratories one above the other for undergraduate teaching. Each laboratory is serviced by a sub-store connected to the main store by a goods lift, and has a balance room and fume room attached. In addition, there are rooms for special teaching purposes. The basement, which extends throughout the wings and the spine, houses the main stores, workshops, glass-blowing, electronic and photographic rooms, and the air-conditioning, heating, liquid nitrogen and electrical plant. The main stores and the separate underground acid and solvents stores are served from ground-level by a goods lift situated in the small extension adjoining the side entrance to the laboratory.

The design of the building is essentially functional. It is built with a steel frame, the walls being

of cavity brickwork with specially selected facing brick. The structural floors are of reinforced concrete, and air-conditioning ducts are carried in the space between floor and ceiling.

Floors in all laboratories and staff rooms are finished with narrow strip African mahogany (karui) boards. The corridor on the ground floor, stair treads, and stair landings and halls are floored with terrazzo tiles. Walls and ceiling are plastered and protected by acid-proof paint.

The heating of the building is by low-pressure hot water, within invisible ceiling panels. The boilers are oil-fired, the heating system being operated in conjunction with the air-conditioning plant, and all rooms are thermostatically controlled.

In addition to the normal a.c. electricity supply, d.c. is available from fixed and mobile rectifier units. Lighting is by tungsten lamps, except in the basement rooms and corridors, where fluorescent strip is used.

The building was constructed on the general principle that all service pipes were to be accessible, and that fixed horizontal drains either in or under the floors were to be avoided. The main pipes and conduits carrying the services, which include gas, hot and cold water, compressed air, distilled water and electricity, and also the heating mains, are slung at ceiling-level along the full length of the basement trolley-way. Branch mains from the main service pipes are run vertically in the service ducts, and the smaller horizontal branches which service individual benches are concealed behind removable polished plywood panels.

The avoidance of floor drains meant a change from the traditional type of 'island' laboratory bench to the 'peninsular' type. All horizontal wastes are within the bench casing above floor-level and discharge

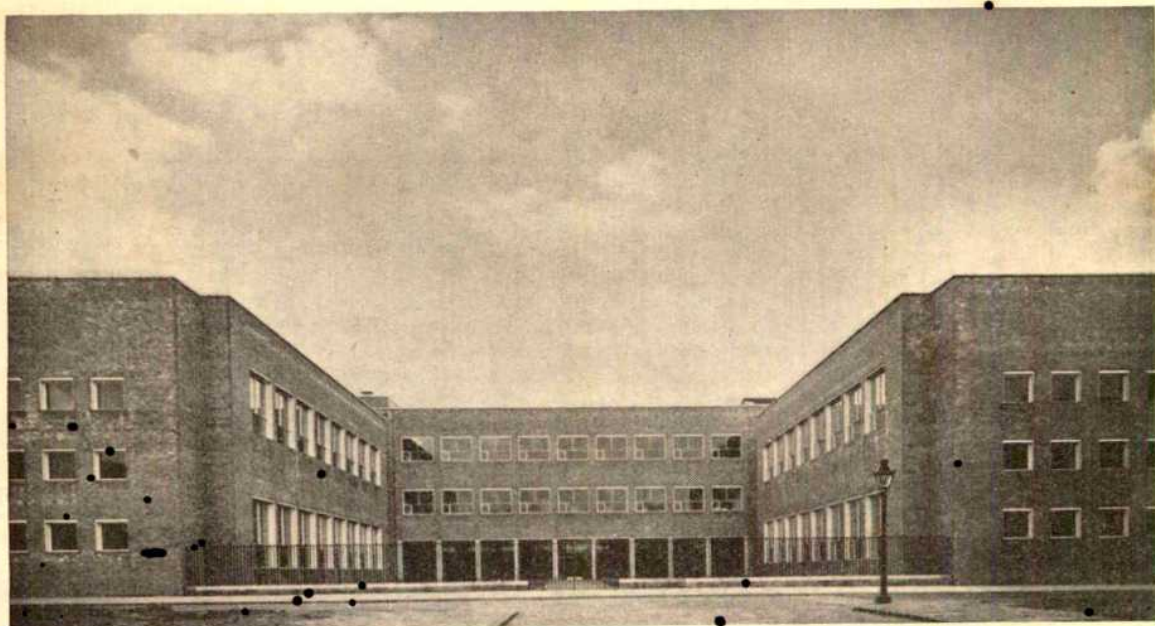


Fig. 1. Front view of Inorganic and Physical Chemistry Laboratories, University of Liverpool

directly into the catchpot, which in turn discharges into a vertical drain stack. The vertical acid-drain stacks occur at 10-ft. intervals, that is, at every steel stanchion between windows and on the centre lines of laboratory benches.

Service pipes to these benches branch off the lines under the window benches, the water, compressed-air pipes and electricity conduits running under the reagent shelf spaced at 15 in. above bench-level, while the gas tubing is taken alongside the waste trough under the bench top. Only gas controls are on the bench top, and these are raised above bench-level to reduce corrosion and to ease cleaning and polishing of the benches. Removal waste bins are an integral part of the bench design.

Polythene ('Vulcathene') has been used for lining the central waste troughs in the benches and the waste pipes from benches, drip sockets and sink traps in all laboratories. The latter, being precision made and thus identical, are readily interchangeable and saved much time and labour in the construction and erection of the benches. The bench tops are constructed of seasoned African teak, and alternate laboratory benches are fitted with a glazed sink or a readily removable inset so that a standard thermostat projecting 9 in. above the bench-level can be inserted. Water, gas and general fittings to the bench are of gun metal.

In all teaching and research laboratories, foul air is extracted at both floor- and ceiling-levels.

Fume cupboards in the teaching laboratories are in a special fume room at one end of the laboratory. The controls for the service points are external and mounted on a black plastic panel under the cupboard working surface. Each fume cupboard is lighted by fluorescent tube fixed above the working surface, and protected from fumes by a removable sheet of obscured glass. Fumes are extracted from the cupboards through high- and low-level outlets in the rear walls by exhaust motors situated in the roof of the building and individually controlled.

The research laboratories have not been individually designed for specialized work, the services and layout being sufficiently flexible for the laboratory to be adapted to any type of chemical research work. Only a few of the laboratories have fixed benches, and in general the normal services have been made available from a 9-in. shelf attached to the wall at 3 ft. above the floor. This arrangement permits full use of space. Soft-wood tables (or metal frames where necessary) of various heights and designs are used for the erection of apparatus. Additional equipment in research rooms are wall channelling, and floor- and ceiling-tapped sockets which may be used for the attachment of blackboard, shelves, electrical apparatus and small-diameter 'scaffolding' for supporting a metal framework. The wall channelling is of a C cross-section, so that threaded bolts can be slid along to any position horizontally, the head of the bolt being in the channel and the threaded shank projecting outwards. The floor sockets are directly below those in the ceiling, and all are at 3-ft. centres, in both directions.

It is proposed to complete the present building within the next two years by the addition of a lecture theatre block comprising three lecture theatres seating 300, 150 and 100, respectively. This block will also house the library and small seminar rooms, and will form a third wing to the main spine. The spine will also be extended to accommodate the newly created Sub-department of Radiochemistry.

HARWELL MEETING OF THE PHYSICAL SOCIETY

THE spring meeting of the Physical Society was held at the Atomic Energy Research Establishment, Harwell, during March 31-April 2; the first day was taken up by discussion of topics connected with nuclear energy-levels, the second with topics connected with neutron physics, and there was a visit to the Harwell laboratories on the morning of April 2. About two hundred and fifty people attended, including several visitors from the Continent of Europe; most of the talks were given by physicists from Harwell and Oxford, the other contributions being from Cambridge and the Imperial College of Science and Technology, London.

The subject of nuclear energy-levels was introduced by B. H. Flowers (Harwell) with a review of the theory of the low-lying levels of nuclei. He directed attention to the contrast between the independent particle (the 'quasi-atomic') model of the nucleus, the chief success of which lies in light nuclei; and the collective, or 'quasi-molecular' model, which has accounted for many of the properties of heavy nuclei. In the first model, one takes a central core with one or more external particles, and considers the interactions between the particles and between the particles and the core. The interaction is usually taken, at one extreme, as pure spin-orbit (j - j coupling) or, at the other extreme, as a force derived from a central two-body potential (L - S coupling). Alternatively, a mixture of the two interactions (intermediate coupling) has been used with success, as Lane has shown with reference to the lithium isotopes and the mirror nuclei carbon-13 and nitrogen-13. Dr. Flowers suggested that experimental evidence should be sought for the odd-parity levels of nuclei between oxygen and calcium; near oxygen these levels probably correspond to $1p$ particles being raised to the $2s$ or $1d$ shells, and near calcium to $1d$ or $2s$ particles being raised to the $2p$ or $1f$ shells. He said that the sequence of spins of these odd-parity levels in oxygen-17 has been observed, by comparison with fluorine-17, to be $1/2$, $7/2$ and $3/2$, as expected; and that he would expect the corresponding sequence of spins for calcium to be $7/2$, $3/2$ and $1/2$. For aluminium-25, intermediate between oxygen and calcium, he would expect an intermediate order, as has been found to be the case. Further theoretical evidence for the validity of intermediate coupling in nuclei with atomic masses between 18 and 20 was later presented by J. P. Elliott (Harwell); many of the experimental data can be fitted with a single value of the coupling parameter, and, in particular for fluorine-19, the energies of the lower even-parity levels, the probability of transitions between these levels, and the log ft values for oxygen-19 and neon-19 decay, can all be accounted for. Experimental evidence for the transition probabilities from the first four levels in fluorine-19, as determined by the gamma-rays from fast-neutron inelastic scattering, was presented by J. M. Freeman (Harwell): the levels were established both by the gamma-ray energies and from excitation functions. In addition to well-established levels, there was good evidence for a level at 1.43 MeV., probably of negative parity. G. Dearnaley (Cambridge) showed results of interesting interference effects which occur when protons or alpha-particles are scattered by fluorine nuclei: the

interference, at a resonance where there is no spin change, occurs because of the interference between the compound nucleus and Rutherford scattering.

Proceeding to the collective or 'quasi-molecular' model of the nucleus, Dr. Flowers referred to the success of the Bohr-Mottelson picture of the rotational levels of even-even nuclei. The moment of inertia of the 'rotating' nucleus is $I = \gamma \beta^2 I_0$, where I_0 is the moment of inertia of a rigid sphere, and β^2 is a distortion parameter. In the Bohr-Mottelson theory, which assumes no vortex motion, the coefficient γ equals 1: but since optical spectrometry (isotope shift) gives β^2 , and nuclear levels give $\gamma \beta^2$, the coefficient γ has been found experimentally to be 4 ± 1 , in accordance with the theory of Blin-Stoyle and Weisskopf, which includes the orbital motions of the shell model. A study in the United States by Mrs. Scharff-Goldhaber has shown that if one plots E_2/E_1 , the ratio of the experimentally determined energies of the second and first excited states of even-even nuclei, as a function of atomic weight, one finds, for heavy nuclei, the value of 3.3, as predicted from the Bohr-Mottelson theory. Near atomic mass 150, however, there is a sharp drop to a reasonably constant value 2.1, even though the individual values of E_2 vary between 0.2 and 2 MeV. Clearly, there is a collective feature present in the nuclei of intermediate weight. In the ensuing discussion, it appeared that the ratio of 2.5 for E_2/E_1 had been derived at Copenhagen by introducing two distortion parameters and large deviations from spherical symmetry. Experimental evidence on collective particle phenomena was given by J. O. Newton (Harwell) in a study of Coulomb excitation of odd Z -even A heavy nuclei. In these, unless the projection of the angular momentum on the axis of deformation is $\frac{1}{2}$, the ratio E_2/E_1 should be a constant determined by the ground-state J : the experimental results give satisfactory agreement for neptunium-237 and uranium-233 (both spin $5/2$) and for plutonium-239 (spin $1/2$), and therefore no relation for E_2/E_1 . For uranium-235, the data could fit spin $5/2$ or $7/2$, and bear no relation to the levels observed in the alpha decay of plutonium-239; this confirms that, in the latter, the levels excited are not the rotational levels based on a ground-state of uranium-235.

Part of one session was given to work from the Harwell cyclotron. Protons scattered out of the cyclotron at 20° from carbon are 70 per cent polarized, and M. J. Brinkworth and B. Rose showed that by slowing down the protons in aluminium to the energy range 2-10 MeV. and scattering a second time in helium, the sign of the polarization can be determined from the known scattering of protons in helium. The sign of the polarization so determined agrees with the sign predicted by Fermi on the basis of the shell-model spin-orbit interaction. Total cross-sections and angular distributions for 140-MeV. protons scattered by beryllium, carbon, nitrogen and oxygen were discussed by A. E. Taylor and E. Wood. The angular distributions showed large Coulomb-nuclear interference and were in agreement with the modified optical model predictions; the total nuclear cross-sections showed close agreement with neutron total cross-sections, except for beryllium which is an odd-neutron nucleus. Measurements of total cross-sections with light and heavy water and with liquid hydrogen showed close agreement between n - n (from the n - D and n - p difference) and p - p scattering, and between the two values of n - p , direct and from the p - D and p - p difference. R. Wilson (Oxford) reported measure-

ments of neutron inelastic cross-sections for carbon, aluminium, copper, cadmium and lead in the energy range 55-140 MeV. The results showed little variation with energy, in contrast to the total cross-sections. Measurements of the elastic scattering for the same elements and for lithium, beryllium, and nitrogen and oxygen molecules at 135 MeV. indicated that the 0° scattering cross-sections were larger than those expected on the optical model, and that the potential in the optical model does not fall to zero at this energy.

The main subject dealt with in the field of slow-neutron physics was the interaction of thermal neutrons with solids and liquids, the subject being introduced by R. J. Elliott (Harwell). Thermal neutrons have wave-lengths in the range 1-10 Å. and are therefore useful for studying the structure of solids; and since the cross-sections of most nuclei are of the same order of magnitude, the positions of atoms such as hydrogen, which are difficult to find by X-rays, can be obtained with neutrons. There is also an interaction between the neutron's magnetic moment and the magnetic moment of an atom, so that magnetic order can be studied with neutrons as well.

The location of hydrogen atoms in organic compounds was later discussed in a paper by G. E. Bacon (Harwell). He said that once the problem of extinction had been properly understood, it was realized that large single crystals could be used for neutron diffraction studies, and this development has made the study of the position of hydrogen atoms in organic compounds feasible. At present, work is going on at Harwell and in the United States at Oak Ridge on several organic compounds. Because of the relatively weak neutron beams available from reactors at the present time, the substances under study are those for which some X-ray data are available: the technique is then to obtain, by Fourier analysis, a projection of the crystal on a single plane only. Bacon showed the results he has obtained on α -resorcinol, in which the positions of the hydrogen atoms have been accurately established for the first time: in this work he used a crystal 1 cm. $\times$ 2 mm. $\times$ 3 mm.

Continuing his review, Dr. Elliott explained that, in addition to the elastic scattering which is being studied in these experiments, the inelastic processes in which the neutron exchanges energy with the solid are of great interest. Since the energy of thermal neutrons is of the same order as the separation of the energy-levels of solids, the excitation or de-excitation of the levels can be studied comparatively easily. Again, because of the nuclear and magnetic interactions, the information obtained is related to both the vibrational and magnetic energy-states of the solid. Unfortunately, because of the relatively weak neutron beams available, really detailed experiments are not yet feasible. However, R. D. Lowde (Harwell) described the data he has obtained from a study of the inelastic scattering of a beam of thermal neutrons by a single crystal of iron. Here both the vibrational and magnetic type of inelastic scattering are important; but by suitable techniques the observational data may be separated into the two components. The magnetic scattering has been compared to that predicted by the Heisenberg and the collective-electron theories of ferromagnetism. At present, the data are accounted for satisfactorily by the Heisenberg model only. Further studies in the neighbourhood of the Curie point have confirmed

that the magnetic scattering reaches a maximum there, and that that phenomenon is analogous to 'critical opalescence'.

The scattering of neutrons by crystalline solids can be described in a relatively exact fashion because the positions of the atoms are relatively well defined. However, Dr. Elliott continued, when more complex substances such as liquids are considered, the scattering is described in terms of a pair distribution function (that is, the distribution of atoms in the liquid as seen from an atom at the origin). For X-ray scattering, only the dependence of the pair distribution function upon the distance between atoms is measured, but for neutron scattering the dependence upon time as well is important. The detailed behaviour of the pair distribution function with respect to time and distance can be found by measuring the differential scattering cross-section per unit solid angle and unit interval of the energy of the scattered neutron.

Again, detailed study of this kind is not yet feasible; but a preliminary experiment on the scattering of 14°K neutrons by solid and liquid lead was described by P. A. Egelstaff (Harwell). The object of the work was to compare the interaction of the neutrons with the thermal vibrations of the solid and liquid. It was shown that the chief features of the experimental data can be explained by assuming that the liquid is "a solid with the atoms placed at random positions". However, some features of the forward scattering require a more detailed model for their explanation.

Limitation of space does not permit a detailed review of all the contributions to the meeting, but mention should be made of the subject of very short half-lives. Prof. S. Devons described the work at the Imperial College of Science and Technology, London, on measurements of absolute gamma transition probabilities by the Doppler shift of the gamma-rays emitted by a recoiling compound nucleus. Here, unexpectedly, the chief unknown has proved to be the rate of slowing down of the heavy particles in the material into which they recoiled. Information is being sought from the recoil of $^9\text{Be}^*$ into varying thicknesses of copper: it was noted that the experimental values of the absolute transition probabilities for $^9\text{Be}^*$ and $^7\text{Li}^*$ lie respectively above and below the values predicted by intermediate coupling theory. C. F. Coleman (Harwell) described a method of determining half-lives down to 10^{-11} sec. by means of fast coincidence techniques. The method depends on $\beta\gamma$ coincidences between two identical detectors placed at 180° with respect to the sample, and differing only in the absorber screening the gamma detector. Alternating the absorber between the detectors enables small delays between the detectors to be cancelled out. The life-times observed (in units of 10^{-11} sec.) are: magnesium-24, 30 ± 2 ; titanium-46, 7 ± 4 ; nickel-60, 8 ± 5 ; selenium-76, 25 ± 10 ; tellurium-122, 196 ± 5 ; and tellurium-124, 13 ± 12 .

M. A. Grace (Oxford) described experiments on the alignment of cobalt-57 at very low temperatures. The determination of polarization correlation with aligned nuclei enabled him to determine the degree of E_2 and M_2 admixtures in the 123-keV. gamma-ray. R. Batchelor (Harwell) described a helium-3 spectrometer for use in the 100-1,000 keV. neutron range. The cross-section of helium-3 in the $^3\text{He}(n,p)^3\text{T}$ reaction has given results in good agreement with those derived from detailed balancing, and the instrument has been used for determining the intensi-

ty and angular distribution near threshold of the $^7\text{Li}(p,n)^7\text{Be}^*$ reaction. Of the $\text{Cu}(n,p)$ reaction at 14 MeV. neutron energy, D. L. Allan (Harwell) showed that the number of protons below the conventional Coulomb barrier at 7 MeV. is far in excess (85 per cent of the total) of those expected, and bears a general resemblance to the distribution observed by Graves and Rosen of the neutrons from the parallel $\text{Cu}(n,n)$ reaction. Finally, the redetermination of the slow-neutron capture cross-section of hydrogen was reported by C. H. Collie and R. E. Meads (Oxford). Neutrons from a pulsed D-D source were slowed down in a tank, and the gamma-rays from their capture were detected in a scintillation counter. The life-time, obtained from the decay-rate of the gamma-ray yield integrated over the tank, was 203 ± 2 $\mu\text{sec.}$, corresponding to a capture cross-section of 0.335 barn for a neutron velocity of 2,200 m./sec.

Other contributors were L. E. Beghian (Oxford) on gamma-rays from fast-neutron scattering; D. B. Gayther and K. P. Nicholson (Harwell) on neutron total cross-sections at intermediate energies; M. J. Poole (Harwell) on the spectrum of neutrons from a water moderator by time-of-flight analysis; P. C. Price (Cambridge) on the radiative capture of alpha-particles in nitrogen; E. R. Rae and J. E. Lynn (Harwell) on the analysis of levels in uranium-238 with a time-of-flight spectrometer; T. H. R. Skyrme (Harwell) on the alpha-particle and shell models of the nucleus; and J. F. Turner (Harwell) on the low-intensity radiations in the decay of cobalt-60.

W. D. ALLEN

P. A. EGELSTAFF

MATERIALS FOR RADIO VALVES

AT a meeting of the Radio Section of the Institution of Electrical Engineers on March 21, a discussion was opened by Dr. R. O. Jenkins on the subject of "Materials for Valves". He stated that, historically, the technique of valve-making was derived from that of lamp-making, so that valves tended to use materials originally developed for lamps. With recent advances, however, modern valves require different and, in some cases, new materials; and since the quantities required are relatively small, it has not always been easy to persuade the supplier of materials to meet the very stringent specification of the valve manufacturer.

In addition to the opening speaker, nine others participated in the discussion. It was generally agreed that most of the materials used in valve manufacture are capable of great improvement, and it was suggested that the preparation of idealized specifications would encourage the supply of satisfactory materials in adequate quantities. The subject was surveyed under the three main headings of cathodes and heaters; other electrodes; and envelopes of both insulators and metals.

It was recognized that in Britain the use of cathode cores made of nickel with a low silicon content has avoided many of the difficulties due to interface troubles experienced in the United States and on the Continent of Europe, where a nickel of high silicon content has been used. The usual material in Britain is a pure commercial nickel with a low sulphur content and 0.05-0.10 per cent of magnesium as a reducing agent. In more recently developed types of valves, however, even the low quantity of silicon

present in pure nickel made it unacceptable for cathode cores, and a possible solution to the problem is the use of a 40 per cent tungsten-nickel alloy. Among the merits claimed for this is that a marked improvement in the ultimate strength can be obtained by a heat-aging process which does not affect the ductility of the alloy. The low thermal conductivity of this alloy is also an advantage.

Grids in receiving valves are usually made by winding either fine molybdenum-tungsten or 5 per cent manganese-nickel alloy wire on to heavier supports of copper, nickel, alloys of these metals or nickel-plated iron. Molybdenum is, however, brittle and expensive; and it can cause poisoning of oxide cathodes if it becomes oxidized. On the other hand, 5 per cent manganese-nickel is not strong enough for many grids. Dr. Jenkins inquired as to the hope of a high-temperature nickel-alloy becoming available to ease this situation. For very fine grid wires, less than 0.001 in. in diameter, tungsten seems likely to be the only suitable material.

Other speakers referred to the difficulty experienced in preventing secondary emission from grids made of molybdenum and tungsten, and suggested that this might be overcome by gold-plating the helix wire; it is difficult, however, to obtain a non-porous plating and one which would still be satisfactory after the swageing of the grid to its support wires.

Receiving valves have relied mainly on envelopes of lime-soda glass, while those parts through which metal connexions are sealed are of lead glass. Increasing use is now being made, in cooled-anode transmitting valves, of the iron-nickel-cobalt alloy matched to a borosilicate glass: this is a very satisfactory combination in that the expansion match is correct over a wide range of temperature.

Probably the most important advance in the field of envelopes is in the use of vacuum-tight ceramics brazed to expansion-matching metals. Originally developed in Germany, this technique is being used extensively in the United States, and will undoubtedly be used in Britain for high-power valves for use at very high and ultra-high frequencies (30-3,000 Mc./s.) in the future. One other important material is pure copper for anodes of transmitting valves and for the blocks of magnetrons and klystrons. So far, it has been found essential to import the necessary high-quality copper; but it is much to be hoped that a satisfactory supply can be established in Britain.

Improvements in radio valves of all types are very dependent on new or improved materials; and this discussion should help towards obtaining these by encouraging co-operation between those engaged in fundamental research on materials, the suppliers of materials and the valve manufacturers.

R. L. SMITH-ROSE

PHYLOGENY OF THE BASIDIOMYCETES

UNDER this title, D. B. O. Savile (*Canad. J. Bot.*, 33, 60; 1955) has contributed an essay in which he first of all sets out a series of "phylogenetic principles", thirteen in all, including some that are original and have a particular application to the fungi.

Each principle is enunciated and then discussed. The first of these may be cited as an example. "New

major groups are never derived from climax groups of the parental stock, but always from unspecialized lower groups of great genetic plasticity; for it is only among the latter that revolutionary changes, usually fatal but occasionally a startling success, are to be expected." From this follows the author's second principle that, since new groups spring from plastic ancestral groups, most of the connecting links perish.

A further principle adopted by the author, though often viewed with caution by botanists, is the well-known one that ontogeny recapitulates phylogeny. That elaborate sexual mechanisms and self-sterility are, in general, of great antiquity appears to be borne out by primitive algae and fungi. Parasitism is not to be regarded as a recent development.

His last principle states that, in cases of strict parasitism, the antiquity of the host reflects that of the parasite and *vice versa*, in that hosts and parasites evolve more or less together.

The application of these principles has led the author to the view that it is difficult to accept any starting point for the Basidiomycetes other than a primitive Ascomycete, very close to *Taphrina* and parasitic upon ancient ferns. The ancestral Basidiomycete gave rise to two main lines, one leading to the rust fungi; the other, by way of the parasitic Auriculariaceae, to the remaining Heterobasidiomycetidae and the Homobasidiomycetidae.

The second line has been characterized by a trend towards increasing saprophytic ability, increasing frequency of clamp connexions, and increasing complexity of fruiting body. The author's views as to the probable phylogenetic relationships are depicted in a number of diagrams. He is emphatic that the phenomenon of parasitism, far from being a recent development and derived from an antecedent saprophytism, is generally ancient in the fungi. The view is advanced that the Ascomycetes originated from parasitic, aquatic Phycomycetes. Saprophytism, in general, takes its place as a derivative condition from an antecedent parasitism.

WORLD CONGRESS OF MEDICAL PRACTITIONERS FOR THE STUDY OF PRESENT-DAY LIVING CONDITIONS

A CONGRESS of medical practitioners, representing thirty countries, was held in Vienna during May 23-25, 1953, with the object of studying present-day living conditions, and the report of the Congress has now been published*. The report begins with the opening address of the honorary president, Prof. E. Stransky, emeritus professor of neuropsychiatry in the University of Vienna, who accepted the honorary presidency on condition that its proceedings should be non-political; but he was compelled by ill-health to hand over the direction of the Congress to the president, Prof. P. Verga, director of the Institute of Anatomy and Pathological Histology of Naples, and director of the Cancer Research Institute in that city.

The main part of the report is divided into three parts: Part I is devoted to forty-two addresses given

* Reports and Proceedings of the World Congress of Doctors for the Study of Present-Day Living Conditions—Vienna, 23-25 May, 1953. Pp. xvi+384. Vienna: Congrès Mondial des Médecins; London: Caversham Centre, 23 Caversham Road, N.W.3. 10s. 6d.

on living conditions in various countries; Part 2, includes the twenty-one addresses given on various aspects of the effects of the Second World War on the physical and mental health of the peoples of a wide variety of countries; and Part 3, which deals with the duties of doctors faced by the problems raised, consists of sixteen addresses on these problems and discussions of them. All these addresses are given in English, French, German and Russian.

The report ends with the three conclusions of the Congress as follows: (1) The medical study of the relationships between improvements in living conditions and improvements in health should be developed; there should be special study of bad

housing, lack of medical care, the incidence of tuberculosis, the infant death-rate and the effects of atomic and other forms of war on tuberculosis, mental illness and ill-health generally. (2) Doctors should not under any pretext depart from their obligation to defend life and health, and they cannot separate individual treatment from problems of social means; for this the free and permanent exchange of ideas and therapeutic methods is necessary. (3) The work begun by the Congress must go on, and an international secretariat should be maintained to make the work of the Congress known, to keep the various countries in touch with one another and to prepare a second Congress.

EFFECT OF THERMAL SHOCK ON THE NUCLEIC ACIDS IN TOAD EMBRYOS DURING EARLY STAGES OF DEVELOPMENT

By H. HASEGAWA

Biological Laboratory, Aichi Liberal-Arts College, Nagoya, Japan

THE quantitative change in content of nucleic acids of amphibian embryos in the course of development has been studied by Brachet and other investigators. All their results are given as values per embryo. Thus quantitative patterns of nucleic acids during amphibian development are shown, while subject to experimental modification.

In view of the importance of the nucleic acids in embryonic development, I have tried to follow the changes of the nucleic acids, after thermal treatment of eggs, during the development of the toad embryo.

Some common Japanese toads, *Bufo vulgaris formosus* (Boulenger), were collected in the middle of March, and eggs were obtained from the uteri and inseminated artificially. 50 min. after insemination, the fertilized eggs thus obtained were transferred to hot water (33°, 35° and 37° C.) for 10 min. They were then cultured at room temperature (10–15° C.) and allowed to develop. The embryos were fixed at several desired stages of development with absolute alcohol, and were used as the experimental series for nucleic acid measurement. Out of forty-nine females

(more than 6,000 eggs per female) three were used for obtaining eggs with the same amount of nucleic acid before fertilization as controls. The quantitative fractionation of the nucleic acids was carried out by the method of Schneider¹, and ribo- and deoxyribonucleic acid were measured photometrically by the orcinol reaction and diphenylamine reaction, respectively. A hundred embryos were used in one nucleic acid determination, and an average was taken of five experiments.

The quantitative changes of the nucleic acids at each stage of development of the eggs treated thermally are shown in Table 1. The ribonucleic acid content of control eggs did not increase until the blastula stage, but after that it increased remarkably. However, in the case of the eggs treated thermally, it was recognizable that the ribonucleic acid content slightly decreased immediately after treatment.

Afterwards, at the two-cell stages, the ribonucleic acid content decreased considerably after treatment at 37° C.; after this drop, it did not increase until the sixteen-cell stages. Then it began to increase rapidly,

Table 1. NUCLEIC ACID CONTENT (γ) DURING THE DEVELOPMENT OF EGGS SUBJECTED TO THERMAL SHOCK (per 100 embryos)*

Exp. stage	Control		33° C. Treatment		35° C. Treatment		37° C. Treatment	
	RNA	DNA	RNA	DNA	RNA	DNA	RNA	DNA
Before fertilization (egg)	581.3±1.24	66.9±0.28	581.3±1.27	66.9±0.26	581.4±1.25	66.8±0.24	581.2±1.28	66.9±0.22
After fertilization (egg)	—	—	580.2±1.33	66.8±0.29	578.3±1.22	66.8±0.27	575.6±1.31	66.9±0.27
2-cell stage	581.2±1.36	66.8±0.34	570.1±1.23	66.7±0.24	562.5±1.38	66.7±0.23	549.8±1.34	66.7±0.26
8-cell stage	581.4±1.21	66.8±0.26	570.4±1.37	66.8±0.31	562.3±1.40	66.8±0.31	549.4±1.31	66.7±0.26
16-cell stage	581.8±1.48	66.9±0.35	570.3±1.34	66.9±0.28	562.4±1.36	66.7±0.34	549.5±1.33	66.8±0.33
Morula	581.6±1.38	67.1±0.36	575.6±1.24	67.1±0.32	572.7±1.31	66.9±0.37	554.7±1.37	66.9±0.36
Blastula	581.4±1.33	69.4±0.42	578.6±1.32	69.3±0.35	576.6±1.42	68.5±0.28	562.6±1.42	68.1±0.41
Early gastrula	583.6±1.44	74.8±0.44	581.8±1.43	74.8±0.41	578.8±1.54	74.8±0.39	571.3±1.46	71.4±0.39
Gastrula	586.5±1.58	86.8±0.37	585.4±1.48	86.8±0.39	582.5±1.61	84.3±0.47	579.4±1.51	80.3±0.47
Neurula	590.8±1.63	124.6±0.43	588.6±1.49	124.6±0.43	588.4±1.58	121.4±0.46	586.5±1.47	116.7±0.51
Tail-bud stage	598.6±1.64	185.4±0.52	597.3±1.57	184.5±0.46	597.3±1.62	178.3±0.47	595.3±1.52	169.4±0.57

* Average of five experiments

Table 2. NUCLEIC ACID CONTENT (γ) IN EMBRYOS WHICH STOPPED DEVELOPMENT AT THE MORULA, BLASTULA AND GASTRULA STAGES DUE TO THERMAL TREATMENT (per 100 embryos)*

Exp. stage	Control		33° C. Treatment		35° C. Treatment		37° C. Treatment	
	RNA	DNA	RNA	DNA	RNA	DNA	RNA	DNA
Morula stage	581.6±1.38	67.1±0.36	570.1±1.42	66.9±0.31	568.1±1.35	66.9±0.28	550.8±1.42	66.9±0.37
Blastula stage	581.4±1.33	69.4±0.42	578.2±1.38	67.1±0.34	570.8±1.51	68.8±0.36	556.8±1.48	66.8±0.39
Gastrula stage	586.5±1.58	86.8±0.37	577.3±1.46	70.4±0.33	572.3±1.47	68.4±0.35	564.8±1.51	67.1±0.35

* Average of three experiments

and at the tail-bud stages it reached nearly the normal ribonucleic acid content.

• The increasing ratio of the ribonucleic acid content, which had decreased after the sixteen-cell stages, was greatest after the treatment at 37° C., at which it showed the greatest decrease.

The deoxyribonucleic acid content of the control eggs did not change until the morula stage; but it increased remarkably after that. That of eggs treated thermally, in contrast to the ribonucleic acid content, did not decrease after the thermal treatment. It increased considerably in the cases of both the control eggs and the eggs treated thermally after the morula stage; but the increase in embryos receiving treatment at 35° C. and 37° C. was a little less than in the control eggs.

The embryos which stopped developing at the morula, blastula and gastrula stages, due to the thermal treatment, lost both their deoxyribonucleic acid and their ribonucleic acid to a much greater extent than those which did not stop growing. The deoxyribonucleic acid content especially decreased greatly.

From these results it is clear that the deoxyribonucleic acid content of the fertilized eggs of the toad is scarcely influenced by development, but that the ribonucleic acid content shows a remarkable decrease. The change of the latter in eggs treated thermally is

similar to the change of nucleic acid content which Steinert² discovered after heat-treatment of the early embryos of *Amblystoma*. The change of nucleic acid content of the control eggs is nearly identical with the results obtained by Hoff-Jørgensen³ with *Rana temporaria*, Sze⁴ with *R. pipiens*, and Steinert² with *R. fusca*.

The decrease of the ribonucleic acid content of the developing embryos after thermal treatment is considered to be brought about by the destruction of cytoplasmic granules (ribonucleoprotein granules) by temperature shock⁵, and its increase after the sixteen-cell stage by the resumption of formation of ribonucleic acid². From the fact that the decrease of the ribonucleic acid content in embryos in the tail-bud stage was not recognized when they were treated at 33° C., but was seen after treatment at 35° and 37° C., treatment at 33° C. seems to have no influence in the tail-bud stage; but treatment at 35° and 37° C. continues to affect the following stages of development.

I thank Dr. T. Yamada, Nagoya University, for valuable criticism.

¹ Schneider, W. C., *J. Biol. Chem.*, **161**, 293 (1954).

² Steinert, M., *Chem. Biol.*, **23**, 549 (1951).

³ Hoff-Jørgensen, E., and Zeuthen, E., *Nature*, **169**, 245 (1952).

⁴ Sze, C., *J. Exp. Zool.*, **122**, 577 (1953).

⁵ Brachet, J., *J. Cyto-embry. Belb-Neerland.*, **50**, 268 (1949).

THE HUMAN INTERVERTEBRAL DISK

By DR. F. HAPPEY, W. G. HORTON and T. P. MACRAE

Bradford Technical College

AND

A. NAYLOR

Royal Infirmary, Bradford

IN earlier experimental work on the structure of the human intervertebral disk, various conclusions were drawn from experiments carried out on partially dried specimens of various ages¹. It is clear that a truly systematic investigation of this problem is difficult because of the obvious impossibility of obtaining specimens other than of a morbid anatomical origin. In consequence, many key experiments have had to be postponed until the necessary specimens were available, and this has retarded our publication of results.

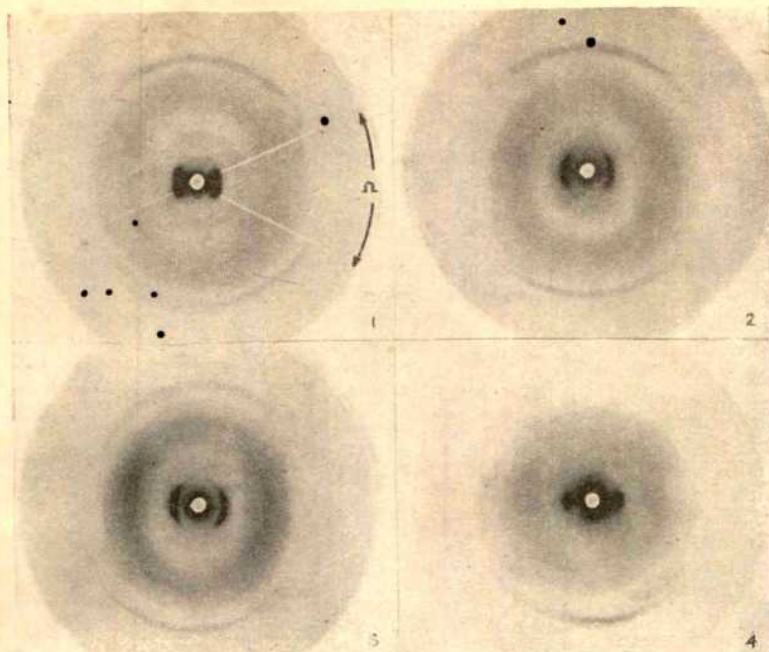
It has now been possible to supplement most of our original work by observations on specimens after freezing. These were sectioned and mounted on the spectrometers of a high-output X-ray tube and photographs obtained with an exposure of $\frac{1}{2}$ –1 hr. This method gave an X-ray diagram which we feel may be more comparable with that from an *in vivo* specimen, as the loss of water is comparatively negligible. Examinations of certain of the specimens have been carried out using the polarizing microscope, and information has been obtained which has been readily correlated with the X-ray evidence.

In our early paper on the very young nucleus, we identified Debye-Scherrer lines on the X-ray diagram, the most intense of which (~ 2.85 Å.) may have been a polar spacing of the collagen diagram. This and the diffuse and disoriented character of the low-angle scatter (10–50 Å.) suggested one of two possibilities: (a) there may be additional crystalline components in the material of the disk other than collagen; or (b) the collagen chains were aligned to

form highly swollen crystallites in which the only clearly defined spacing was that along the fibre axis. It is now clear that the former hypothesis is the more acceptable, as the sample we originally used and photographed after ageing for some time has shown that the main additional reflexions can be identified as those from sodium chloride. Further, the Debye-Scherrer lines have developed a discontinuous appearance typical of a powder of an inorganic salt, whereas originally they were broad and continuous. From this result, which was verified by other observations, it appears that in the nucleus of the very young disk—up to approximately two years—there is a salt content which tends to decrease with age and which does not show on the X-ray diagram after about two years of age. This matter is a subject of further study at the present time.

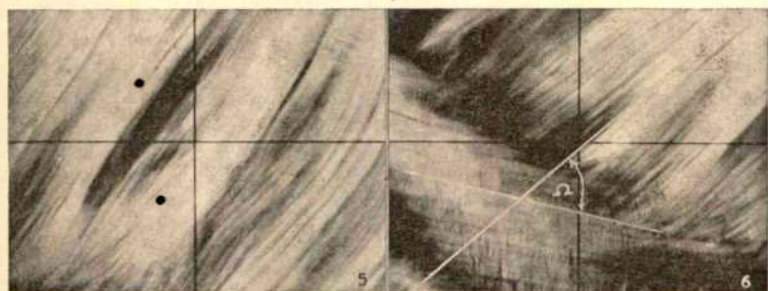
The second series of observations which appear of importance show the striking difference between the results obtained on specimens with a normal *in vivo* water content and the partially dried specimens of our earlier investigations. We were able to direct attention to this possibility towards the end of our original paper, but the differences are even more marked than we suspected at that stage.

In the first place, the cross-banded structure appears in the human disk at a much earlier age than that indicated by our original measurements. From an extensive series of observations, we feel that there is considerable resolution of the biaxial orientation in early adolescence, and that some biaxial orientation



(1) Annulus fibrosus, age 25 years. Specimen *in vivo* condition showing biaxial form of collagen fibrils. (2) Annulus fibrosus, age 25 years. Specimen partially dried and showing inhibition of the biaxial arrangement. (3) Annulus fibrosus, age 25 years. Specimen air-dry, showing equatorial arcs coalescing into a single arc around equator of fibre. Diagram with large angular dispersion. (4) Annulus fibrosus, age 63 years. Single sliver teased from the wall of the disk. Fibre axis probably tilted with respect to specimen axis as the 4.0 Å. and 2.86 Å. meridional reflexions on one side of the diagram are very weak.

Photographs were obtained using copper K α radiation. Specimens of the annulus fibrosus were mounted so that the X-ray beam was perpendicular to the spinal axis and parallel to the radial direction of the disk.



(5) Photomicrograph using polarized light showing the uniaxial orientation of the fibrils (see Fig. 4). (6) Photomicrograph using polarized light showing the biaxial orientation of the fibrils. The mutual orientation of the fibrils is at an angle of Ω in the plane of the disk wall. This orientation is also shown by the angle Ω between the equatorial reflexions in the X-ray diagram of Fig. 1.

may be present in the annulus of the very aged disk. In our earlier work with partially dried specimens, we were able to demonstrate a biaxial structure only in middle-aged disks. To clarify this apparent discrepancy between *in vivo* and air-dried specimens, an annular specimen was photographed during drying, and it was clearly shown that in the younger specimens the biaxial character of the orientation was inhibited by the drying process. Figs. 1, 2 and 3 show the disorientation process occurring on drying in a disk of age twenty-five years. It is interesting to consider the reasons for such processes, and it is possible that the wall distortion on drying is greater in the younger disks where the absorbed water in the inter-fibrillar matrix is greater than in the more crystalline and collagenous structures of the older disks. It has now been possible, on air-drying the latter specimens, to

show a wall structure in which the equatorial arcs have not fused together and a biaxial arrangement of the collagen fibrils is retained.

Having established this type of X-ray diagram from the wall of the annulus fibrosus, it is possible that the diagram may arise from one of two distributions of the collagen in the disk wall. It may be arranged in superimposed flat sheets distributed around the wall as previously described, or the crystallites may be in a helical form. It is, however, fairly certain that the former is the more likely structure, as a technique of sectioning has been developed in which individual sheets of collagen can be dissected from the disk; these have a uniaxial arrangement when viewed in a polarizing microscope and give a highly oriented and crystalline collagen diagram when examined by X-rays. This structure is shown in Fig. 4, and it can be seen how similar the diagram is to that of highly orientated rat-tail tendon. Fig. 5 is a polarizing microscope photograph of such a specimen showing single striations in the wall, and Fig. 6 is one from the same disk in which the biaxial orientation of the collagen sheets can be clearly seen, and in which the fibrils have a mutual orientation of Ω in the circumference of the disk. An X-ray photograph of a similar specimen gave a biaxial diagram as in Fig. 1.

In the nucleus pulposus a study is being made of the possible presence of components other than collagen in samples dried in a desiccator. Here, reflexions which are not characteristic of the collagen pattern or of common salt have been obtained on X-ray diagrams of such materials.

Although this communication is only a brief survey of the present trend of our work, it is important that the results obtained from the

dried specimens of intervertebral disk should be considered in their proper perspective, because although we felt that in our earlier work the *in vivo* specimens would be different from the partially dried samples, such wide differences of structure were rather surprising. A more detailed account of this work will be published in due course elsewhere.

This work forms part of a scheme of fundamental research on the structure of fibrous proteins being carried out in the Bradford Technical College. One of us (W. G. H.) is indebted to the Bradford Education Authority and the Bradford Group 'A' Hospital Management Committee for a joint scholarship to carry out this work.

[Dec. 22

¹ Happey, F., MacRae, T. J., and Naylor, A., in "The Nature and Structure of Collagen", edit. by Randall, J. T. (Butterworth, London, 1953).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Thermodynamic Data for Myoglobin, Haemoglobin and Cytochrome-c Reactions, and the Position of the Haem Groups

CONANT¹ first put forward the idea that the haems in haemoglobin are held by two bonds of unequal strength between the iron and groups in the protein on both sides of the haem disk, the weaker bond breaking when combination with oxygen, carbon monoxide, etc., occurs. This crevice configuration has been elaborated to explain various features of its reactions by Coryell and Pauling, Wyman, and St. George and Pauling; but Keilin has laid stress on other aspects, particularly the combination with large molecules such as nitrosobenzene and 4-methyl imidazole, which suggest that the haem iron is not embedded in a crevice but is readily accessible².

Unfortunately, few of the experimental techniques which give direct quantitative evidence on molecular configuration are applicable to haemoproteins. From a study of unit-cell dimensions in crystals of met-myoglobin and its 4-methyl imidazole complex, Kendrew and Parrish³ conclude that the haem group is more likely to be located on the surface than in a deep crevice. No similar data are available yet for methaemoglobin. But information relating to the crystalline state, valuable as it is, does not necessarily give a true picture of the configuration of such large molecules in aqueous solution, the medium in which their reactions have almost exclusively been studied, and one which is more strictly comparable to their environment *in vivo*. On the other hand, a comparison of thermodynamic data for corresponding haemoprotein reactions, especially the entropy changes, does offer a basis for judging to what extent the changes in configuration which accompany the reactions are similar, and hence for judging to what extent the actual configurations of the haem groups are also similar, when the molecules are in solution.

Fortunately, there is no doubt that the haem in cytochrome-c is bound in a crevice. It reacts extremely slowly, if at all, with the usual ligands between pH 4 and 11, and its spectroscopic and magnetic properties show the haem to be bonded as in a haemochromogen, where the fifth and sixth co-ordination positions of the iron, on either side of the haem, are occupied by nitrogenous substances⁴. The thermodynamic data for its reactions can therefore be taken as characteristic of haem in a crevice configuration. There is a very great contrast between the data for cyanide-complex formation by ferricytochrome-c and ferri-myoglobin, as shown in Table 1^{5,6}. Although the affinities (free-energy changes) are quite similar, the ferri-myoglobin reaction is greatly favoured by the change in heat content, yet the entropy change is very disadvantageous; whereas the ferricytochrome-c reaction is even slightly endothermic and its complex forms entirely by virtue of the very favourable entropy change. This kind of contrast is just what would be expected if the haem were in a crevice in cytochrome-c and relatively exposed on the surface in myoglobin. In the former case, energy would be required to break the bond to the more weakly held

amino-acid residue, thus diminishing the net exothermicity of complex formation; but the entropy change would be favourable because a considerable part of the protein would gain far more freedom of movement. The great magnitude of the differences, 20 kcal./mole and 55 e.u., suggests that in myoglobin the sixth co-ordination position is far more exposed to ligand attack, and if a crevice configuration is present then it is in no way comparable to that in cytochrome-c.

Table 1. THERMODYNAMIC DATA FOR THE FORMATION OF CYANIDE COMPLEXES BY REACTION WITH THE CYANIDE ION, AT 25° C.

	ΔG° (kcal./mole)	ΔH° (kcal./mole)	ΔS° (e.u.)
Ferrimyoglobin	-11.4	-18.6	-24
Ferricytochrome-c	-8.3	+1.1	+31.3
Differences:	-3.1	-19.7	-55.3

Table 2. THERMODYNAMIC DATA FOR FERRIMYOGLOBIN (METMb) AND FERRIHAEMOGLOBIN (METHb) REACTIONS, AT 25° C.

Reaction		ΔG° (kcal./mole)	ΔH° (kcal./mole)	ΔS° (e.u.)
Complex formation with OH ⁻	MetMb	-6.9	-7.7	-2.6
	MetHb	-7.1	-9.5	-7.9
Complex formation with F ⁻	MetMb	-2.0	-1.5	+1.8
	MetHb	-2.4	-2.5	-0.6
Reduction by H ₂ (standard cell reaction)	MetMb	-2.7	-13.7	-37.0
	MetHb	-3.6	-15.2	-39.0

Results for the cyanide reaction of ferrihaemoglobin are not yet available, but a comparison with ferri-myoglobin is possible for three other reactions as shown in Table 2⁶⁻⁸. These results, like those in Table 1, refer to highly purified haemoprotein preparations; with ferrihaemoglobin, haem-haem interaction was completely absent since hyperbolic and not sigmoid dissociation and titration curves were obtained. The great similarity between the results, which differ at most by only 1.8 kcal./mole in ΔH° and 5.3 e.u. in ΔS° , suggests very strongly that the haem is very similarly situated in both haemoproteins in this purified condition. If anything, for all three reactions the entropy changes are less favourable for ferrihaemoglobin and the change in heat content more favourable; so, in view of the above comparison with ferricytochrome-c, ferrihaemoglobin shows to an even less extent than ferri-myoglobin the characteristic behaviour of haem situated in a crevice.

A discussion of haem-haem interaction in relation to the entropy changes in haemoprotein reactions and those with inorganic co-ordination complexes is being published elsewhere⁹.

The work reported above forms part of a research programme supported by grants from the Medical Research Council and the Nuffield Foundation which we gratefully acknowledge.

PHILIP GEORGE
G. I. H. HANANIA

Department of Colloid Science,
University, Cambridge.
Feb. 15.

¹ Conant, J. B., Harvey Lectures, 23, 159 (1932-33).

² Keilin, D., *Nature*, 171, 922 (1953), with ref. to Coryell and Pauling, etc.

³ Kendrew, J. C., and Parrish, R. G., *Nature*, 175, 206 (1955).

⁴ see Margolash, E., *Nature*, 175, 293 (1955).

⁵ George, P., and Tsou, C. L., *Biochem. J.*, 50, 440 (1952).

⁶ George, P., and Hanania, G. I. H. (unpublished results).

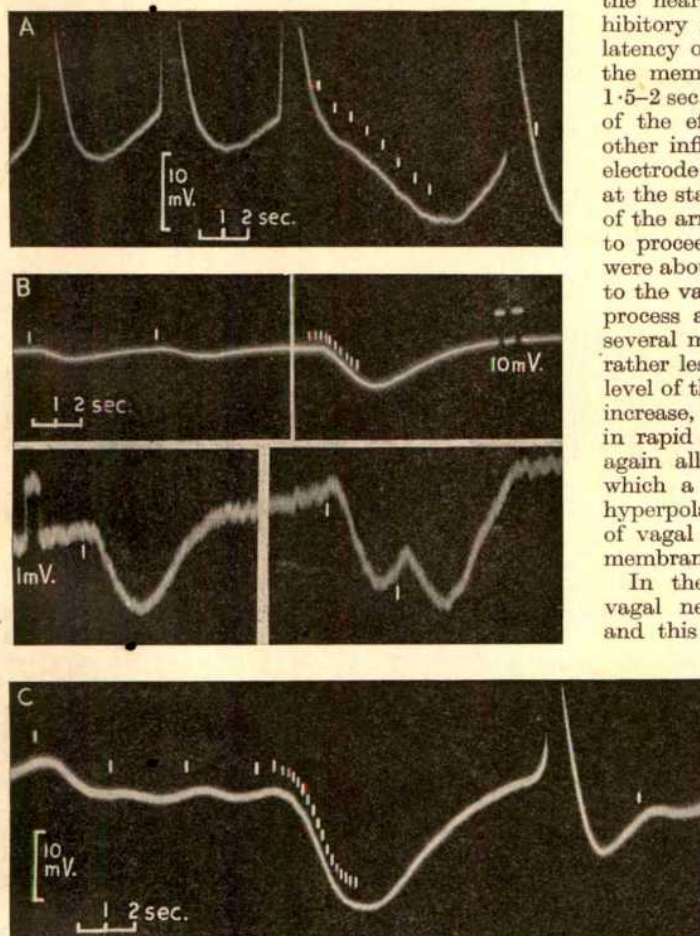
⁷ George, P., and Hanania, G. I. H., *Biochem. J.*, 52, 517 (1952); 55, 236 (1953).

⁸ Scheler, W., and Jung, F., *Biochem. Z.*, 325, 515 (1954).

⁹ George, P., "Currents in Biochemical Research", 2 (Interscience, New York, in the press).

Production of Membrane Potential Changes in the Frog's Heart by Inhibitory Nerve Impulses

THE observations reported here were made in the course of preliminary experiments concerned with the electrical changes which vagal and sympathetic nerve impulses produce in the pace-maker region of the heart. The preparation was the sinus venosus of the frog together with its nerve supply (one or both vagi; more recently, the intra-cranial roots and sympathetic components of the vagus were prepared for separate stimulation). A micro-electrode was



Intracellular recording from the sinus venosus of the frog's heart. Single stimuli to the vagus are indicated by white dashes. Depolarization is signalled by upward deflexion of trace. Note: slow spontaneous depolarization precedes the spike potential; vagal impulses are followed by transient hyperpolarization.

used for intracellular recording of the membrane potential, the electrode being introduced into the sinus through the exposed sino-auricular ostium or through the cut inferior vena cava. Although the nervous control of the heart is not restricted to its pace-maker region, we were especially interested in the mechanism by which nerve impulses regulate the beat frequency, and an attempt was therefore made to place the recording electrode as close as possible to the point of origin of the rhythmic activity. This place can be recognized by the appearance of a slow depolarization preceding each action potential^{1,2}, and the accompanying records were obtained from such regions.

In (A), the recording electrode had been inserted into an active part of the sinus, beating at a rate of about 12 per min. The highest level of the membrane potential, in the interval between the action potentials, was about 50 mV. After the third beat, a series of stimuli (indicated by dashes) were applied to the vagus, causing an increase of the membrane potential (downward displacement of the trace) accompanied by a stoppage of the beat. After the end of the vagal stimuli, the membrane potential fell and another impulse arose.

In (B) and (C), the effects of single and repetitive vagal shocks are shown during a state of arrest of the heart produced by a preceding burst of inhibitory impulses. Each shock is followed, after a latency of about 0.5 sec., by a transient increase of the membrane potential reaching a peak in about 1.5–2 sec. and lasting 5–7 sec. (16° C.). The amplitude of the effect varied greatly; it depended, among other influences, upon the position of the recording electrode and the timing of the stimulus. For example, at the start of record C, the slow local depolarization of the arrested pace-maker region had been allowed to proceed towards a level at which renewed beats were about to occur. A single shock was then applied to the vagus (first dash), stopping the depolarization process and increasing the membrane potential by several millivolts. The next few shocks contributed rather less and only served to maintain the average level of the potential; to obtain a further substantial increase, it was necessary to fire a series of impulses in rapid succession. After this, depolarization was again allowed to develop, this time to a point at which a new action potential arose. The largest hyperpolarization so far obtained during a burst of vagal impulses amounted to 33 mV. (raising the membrane potential from 50 to 83 mV.).

In the experiment illustrated here, the mixed vagal nerve ('vago-sympathetic') was stimulated, and this may have resulted in some complication.

Thus, the obvious enhancement of the 'post-vagal' spike and its lowered firing threshold (in A and C) may have been due, in part, to a delayed action of sympathetic impulses (as was found to occur in other experiments in which the component nerves were stimulated separately). However, the hyperpolarization which accompanies the immediate inhibitory effect was confirmed when the intracranial vagal roots were excited alone. These observations agree well with the classical, but sometimes disputed, findings made by Gaskell³ on the quiescent auricle of the tortoise, namely, the occurrence of a positive variation of the injury potential during excitation of the inhibitory nerve fibres of the heart.

This work was supported by a grant made by the Nuffield Foundation.

J. DEL CASTILLO
B. KATZ

Department of Biophysics,
University College,
London, W.C.1.
March 30.

¹ Weidmann, S., *J. Physiol.*, 115, 227 (1951).

² Trautwein, W., and Zink, K., *Pflüg. Arch. ges. Physiol.*, 256, 68 (1952).

³ Gaskell, W. H., *J. Physiol.*, 8, 404 (1887).

Development of Fertilizing Capacity of Rabbit Spermatozoa in the Uterus

By deposition of sperm into the Fallopian tubes of a rabbit at various times before or after ovulation, it has been found¹ that ejaculated or epididymal spermatozoa require about six hours stay in the tubes to acquire their fertilizing capacity. Although sperm incubated in the uterus of a live animal for five hours was found to be capable of fertilization when deposited into the tube, the time requirement in the uterus was not systematically determined. The following experiment provides more direct evidence to show that spermatozoa placed in the uterus also require a definite period of time to develop their fertilizing capacity. However, attempts to develop the fertilizing capacity of ejaculated sperm *in vitro* have been unsuccessful.

The uterine spermatozoa were obtained by centrifugation of saline washings of rabbit uteri at various times after two fertile matings. They were then transferred into Fallopian tubes where recently shed ova were present. Doe rabbits were injected intravenously with sheep pituitary extracts to induce ovulation, which occurs about ten hours later. At 11½–12½ hours after injection, flank incisions were made under 'Nembutal' anaesthesia and about 0.03–0.06 ml. of the centrifuged uterine sperm suspension was deposited into each tube through the infundibulum. The concentration of spermatozoa was estimated and the number of spermatozoa deposited into each tube was calculated. One day after operation, the rabbits were killed and their tubes were flushed with saline to recover ova which, if fertilized, would be at about the 8-cell stage. The ova thus recovered were mounted in saline on a slide under a cover slip. They were examined under a compound microscope before fixation, after fixation with acetic alcohol, and again after being stained with acetic lacmoid² in order to make certain that cleaved ova were fertilized.

It is quite clear from Table 1 that fertilization failed when deposited spermatozoa were ejaculated, epididymal, or recovered from the uterus 2–4 hr. after mating. The percentage of fertilized ova, however, increased from 38 to 77 per cent when the deposited spermatozoa were recovered from the uterus of a rabbit 6–16 hr. after mating. Since the fertilizing capacity of spermatozoa is lost after thirty hours in the female tract³, the relatively low percentage of fertilized ova (56 per cent) resulting from the deposition of 24-hr. uterine sperm is therefore to be expected.

Deposition of ejaculated sperm either incubated at 38° C. or stored at 10° C. for 2–16 hr. in saline, in saline containing an equal volume of rabbit serum, or in saline containing Chicago blue or Congo red which induces sperm agglutination, or deposition of fresh ejaculated sperm suspended in saline containing tryptophan, glutamic acid, thiamine, ascorbic acid, glutathione, succinic acid, fructose or glucose all failed to effect fertilization. Deposition of sperm incubated at 38° C. or stored at 10° C. in uterine washings in the presence of endometrial scrapings or in the lumen of an excised uterus for 12–16 hr. also failed to effect fertilization except in two doubtful ova out of a total of 139.

The total number of spermatozoa recovered from both the uteri of a rabbit mated at least twice by fertile males (at least 300 million spermatozoa ejaculated into the vagina) was extremely low, ranging from 0.38 to 4.2 million, and the highest

Table 1. DEVELOPMENT OF FERTILIZING CAPACITY OF RABBIT SPERMATOZOA IN THE UTERUS

Sperm deposited	No. of rabbits	No. of sperm deposited into each tube (range)	Ova recovered		Percentage of ova fertilized
			Total	Fertilized	
Uterine (hr. between mating and recovery)					
2	7	30,000–46,000	73	0	0
4	8	20,000–198,000	86	0	0
6	8	40,000–116,000	69	26	38
12	11	20,000–180,000	117	63	54
16	5	27,000–630,000	65	50	77
24	5	25,000–57,000	55	31	56
Epididymal					
Fresh, centrifuged	5	80,000–1,400,000	52	0	0
Ejaculated					
Fresh, centrifuged	8	630,000–8,800,000	107	0	0
In various solutions for different times	17	15,000–1,230,000	274	0	0
Incubated or stored in uterus fluid, endometrium, or in excised uterus	12	154,000–1,640,000	139	2?	0

count was obtained from the uteri of rabbits 12 hr. after mating. The difference in the proportion of fertilized ova among groups is, however, not related to the total number of sperm deposited into each tube. Nevertheless, it is quite possible that the percentage of fertilized ova may be related to the number of sperm within any one group.

The ova fertilized by tubal insemination are capable of developing into normal young, since normal fetuses were obtained from animals receiving 6-, 12- or 24-hr. uterine sperm.

The failure of fertilization in the deposition of ejaculated, epididymal, or 2–4 hr. uterine sperm is mainly due to the failure of spermatozoa to penetrate into the zona pellucida, because all the unfertilized ova had 1–30 or more spermatozoa on the surface of the zona pellucida but not one penetrated into the perivitelline space. The failure of fertilization of some ova after deposition of 12- to 24-hr. uterine sperm is probably due to the absence of spermatozoa in the vicinity of ova before the ova lost their fertilizability, since fertilizability of rabbit ova after ovulation is only 6–8 hr.^{3,4} at the most.

In the previous study¹, a high proportion of fertilized ova was obtained when 5-hr. uterine sperm was deposited in the tubes of rabbits 2 hr. before ovulation, but a low proportion of fertilized ova was obtained when the same sperm was deposited into the tubes of rabbits 2 hr. after ovulation. This is probably due in the former case to the partial development of fertilizing capacity in the uterus first, which was completed later in the tube before the loss of fertilizability of the ova; and, in the latter case, to the loss of fertilizability of the ova before the attainment of fertilizing capacity by the sperm. Furthermore, it was mentioned⁵ that the percentage of fertilized ova was lower when the deposited sperm was incubated in the uterus of a live animal for a shorter time, 2 hr., than for a longer time, 6 hr. In that experiment, the uterine sperm was deposited 2 hr. before ovulation, in which case there is still

a chance for the sperm to complete the process of development in the tube. In the present study, rabbits 2 hr. after ovulation were used and no fertilization was observed, even if the deposited sperm was recovered from the uterus 4 hr. after mating. This is probably due to the loss of fertilizability of ova before the completion of fertilizing capacity in the tubes. These results indicate that the development of fertilizing capacity of sperm can be partially achieved in the uterus and then completed in the tubes.

That the spermatozoa must spend some time in the Fallopian tubes before they are capable of fertilization has also been demonstrated by the deposition of sperm in the tubes of rabbits or into the peri-ovarian sac of rats⁶, by the examination of the number of spermatozoa about the ova and the number of penetrated ova in the rat⁷, and by the examination of the number of penetrated ova after delayed mating in the rabbit and in the rat⁸. This is, however, the first experimental demonstration of the development of fertilizing capacity in the uterus. The fertilization of mammalian ova *in vitro* has never been conclusively demonstrated^{9,10}. Since the demonstration that spermatozoa require a certain length of time in the female tract to attain their fertilizing capacity^{1,8}, the fertilization of rabbit ova *in vitro* by means of sperm recovered from the tubes of a rabbit 12 hr. after mating was achieved¹¹, and the penetration of spermatozoa into rabbit ova cultured in the utero-tubal secretion containing spermatozoa was also reported¹². It is quite clear from the present direct evidence and the recent contributions by other workers that the spermatozoa require a certain length of time either in the uterus or in the Fallopian tubes to develop their fertilizing capacity. Biochemical aspects of the developmental process in the female tract are under investigation.

This work has been aided by grants from the Josiah Macy Jr. Foundation and the Population Council. Thanks are due to Miss Faith Andrews for assistance and to Dr. G. Pincus for his interest.

M. C. CHANG

Worcester Foundation for Experimental Biology,

Shrewsbury, Mass.

Feb. 20.

¹ Chang, M. C., *Nature*, 168, 697 (1951).

² Chang, M. C., *J. Exp. Zool.*, 121, 351 (1952).

³ Hammond, J., and Asdell, S. A., *Brit. J. Exp. Biol.*, 4, 155 (1926).

⁴ Hammond, J., *J. Exp. Biol.*, 11, 140 (1934).

⁵ Chang, M. C., "Mammalian Germ Cells" (Ciba Found. Symp., Churchill, London, 1953).

⁶ Austin, C. R., *Aust. J. Sci. Res.*, B, 4, 581 (1951).

⁷ Austin, C. R., *Nature*, 170, 326 (1952).

⁸ Austin, C. R., and Braden, A. W. H., *Aust. J. Biol. Sci.*, 7, 179 (1954).

⁹ Chang, M. C., and Pincus, G., *Physiol. Rev.*, 31, 1 (1951).

¹⁰ Smith, A. U., "The Biochemistry of Fertilization and the Gametes", Biochem. Soc. Symp. No. 7 (1951).

¹¹ Dausier, L., Thibault, C., and Wintenberger, S., *C.R. Acad. Sci., Paris*, 238, 844 (1954).

¹² Moricard, R., *Nature*, 173, 1140 (1954).

Effect of Triethylene Melamine on the Fertility of Rats

OBSERVATIONS made during the course of investigations into the effect of prolonged treatment with triethylene melamine on the growth of the Walker carcinosarcoma¹ have led to the observation that this drug produces a selective effect on the male reproductive system and the early embryo.

Table 1. EFFECT OF CONTINUED TREATMENT WITH TRIETHYLENE MELAMINE ON THE FERTILITY OF MALE RATS

All the females used were known to be fertile, and fresh groups were introduced for each breeding test. The figures marked * are rest from mating the five treated males with ten females as a control; the remainder are from isolated matings. The failure in the control series was due to the persistent infertility of one male.

Dose (mgm./kgm.)	Treatment	Mating periods (days from zero time)	Number of litter	
			Treated	Control
0.2	21 doses in all, given as five daily doses initially and the remainder twice-weekly. The course ended on day 57.	16-38	0/10*	10/10*
		58-65	0/5	4/5
		72-80	0/5	4/5
		90-98	0/5	4/5
		105-122	0/5	4/5
0.05	41 doses given in a period of 57 days	16-38	0/10*	10/10*
		58-65	0/5	4/5
		72-80	0/5	4/5
		90-98	3/5	4/5
		105-122	4/5	4/5

Continued administration of triethylene melamine to male rats has shown that 0.05 mgm./kgm. daily is effective in producing and maintaining sterility 100 per cent of animals, while a similar result obtained by the less-frequent injection of 0.2 mgm/kgm. (Table 1). In males receiving the lower dose sterility persisted for three to four weeks after cessation of treatment; those given the higher dose (0.2 mgm./kgm.) have continued to remain sterile up to the time of writing (eight weeks). In the entire period of infertility, both during and after treatment these animals produce spermatozoa and regular impregnate the females with which they are mated. Short courses of treatment, for example, 0.2 mgm/kgm. daily for five days, produce periods of sterility lasting for a few weeks. 24 hr. after a single dose of triethylene melamine (0.2 mgm./kgm.), isolated matings were successful during a period of four days. Fresh females introduced to the same males six days after the treatment did not produce litters, although insemination occurred. These results suggest that the drug does not interfere with the function of mature spermatozoa, but only with those formed after treatment. A detailed examination of the action of the compound on spermatogenesis is in progress.

The fertility of adult female rats was unaffected after a short course of triethylene melamine (0 mgm./kgm. daily for five days). The same treatment commencing on the fourth day after mating with a similar number of untreated males resulted in a complete failure to produce litters. In identical control series, litters were obtained from every animal.

It seems certain that these actions of triethylene melamine are due to a direct effect on the reproductive system, and that the amount of drug involved is very small. Since virtually nothing is known about the mode of action of ethylenimine as tumor inhibitors, the selective interference by triethylene melamine with the reproductive process is interesting. The dose-levels used produced no obvious signs of toxicity, apart from interference with gain in weight. Hendry, Homer, Rose and Walpole² refer briefly to the histological appearance of the rat testis following a single lethal dose of triethylene melamine by the intraperitoneal route. The effects were stated to range from "loss of spermatogenesis with desquamation in a few tubules only, to complete atrophy". The carcinogenicity of this compound has also been demonstrated in rats³, but no undesirable effects have been manifest in any of our treated animals, although some have now been kept for or

year from the period of treatment. The ability of other anti-tumour agents to interfere specifically with male fertility is being investigated. Full details of this work will be published elsewhere.

HAROLD JACKSON
MARION BOOK

Dept. of Experimental Radiation Therapeutics,
Christie Hospital and Holt Radium Institute,
Manchester 20. March 16.

¹ Jackson, H., *Brit. J. Cancer*, 8, 336 (1954).

² Hendry, J. A., Homer, R. F., Rose, F. L., and Walpole, A. L., *Brit. J. Pharmacol. Chemother.*, 6, 357 (1951).

³ Walpole, A. L., Roberts, D. C., Rose, F. L., Hendry, J. A., and Homer, R. F., *Brit. J. Pharmacol. Chemother.*, 9, 306 (1954).

Polyspermy after Induced Hyperthermia in Rats

It was reported earlier¹ that the incidence of polyspermy in rats increased about seven times if coitus were not permitted at the normal time but delayed until after ovulation. When coitus occurred between 8 and 10 a.m., nearly 9 per cent of the eggs became polyspermic, whereas after normal mating only a little more than 1 per cent were polyspermic. These results were obtained in Sydney, Australia, with rats of an albino type.

Recently, the attempt was made to repeat these observations in London, and for the purpose two strains of laboratory rat were used: an albino and a 'hooded' strain. In spite of almost daily trials extending over a period of two months with the albino rats, delayed mating occurred at only two out of about 150 opportunities; neither of these rats yielded polyspermic eggs. The hooded female rats were more willing to perform coitus after ovulation; but even these mated much less readily than did the rats used in Sydney. Moreover, the incidence of polyspermy, as seen in 428 eggs from thirty-six hooded rats, was only 2.2 per cent. As a control group of thirty rats, allowed free mating, gave an incidence of 1.9 per cent, it was apparent that, in contrast to the Sydney results, the frequency of polyspermic fertilization had been virtually unaffected by delaying coitus until after ovulation.

It is tempting to ascribe the regional differences in willingness to mate belatedly, and in the incidence of polyspermy, to differences in strain characteristics of the rats used. However, evidence has now been obtained which indicates that environmental differences may also have been responsible: a high environmental temperature has been found to have a profound effect on the block to polyspermy.

Observations were made on ten hooded rats. Immediately after delayed mating, each rat was kept for about six hours in an electrically heated box, and heating was controlled so as to maintain the animal's body temperature a few degrees above the normal level of about 38.5°C. Box temperatures ranged from 35° to 42°C. The mean of the body temperatures of the rats during the heating period was 40.6°C. and the mean maximum temperature reached was 42.1°C. On slaughter the following day, a total of 109 eggs was recovered. There were ninety-one sperm-penetrated eggs, and eighteen, or 19.8 per cent, of these were polyspermic, including three tetraspermic eggs and one pentaspermic egg. Moreover, the results showed that, of all the eggs that theoretically could have become polyspermic (because two or more sperms had passed through the zona pellucida), 75 per cent actually became polyspermic.

In the rats used, therefore, a readily tolerated hyperthermia exerted a powerful inhibitory action upon the development of the block to polyspermy. The effect was similar to, but rather more striking than, that observed after the local application of a 'hot-shock' to the eggs in the Fallopian tube². Consequently, it seems possible that changes in body temperature even within the normal physiological range may have a perceptible influence upon the reactions of the egg to sperm penetration. Investigations are continuing on the effects of variations in body temperature on fertilization, and a full report will be made later.

C. R. AUSTIN

National Institute for Medical Research,
Mill Hill, London, N.W.7.
Jan. 21.

¹ Austin, C. R., and Braden, A. W. H., *Nature*, 172, 82, (1953); *Aust. J. Biol. Sci.*, 6, 674 (1953).

² Austin, C. R., and Braden, A. W. H., *Aust. J. Biol. Sci.*, 7, 195 (1954).

Chromosome Aberrations caused by Radioactive Thymidine

CHROMOSOME aberrations in onion root tips treated with 2-¹⁴C-thymine deoxyriboside (thymidine) and with 2-¹⁴C-thymine have been studied. It has been found that radioactive thymidine gives a significantly higher frequency of aberration than equivalent amounts of radioactive thymine. Since thymidine is a precursor of deoxyribonucleic acid thymine^{1,2} and becomes a part of the deoxyribonucleic acid structure without diversion to any known cytoplasmic component including ribonucleic acid, a unique system is available for provoking intranuclear damage. Thymine, on the other hand, is not incorporated into deoxyribonucleic acid^{2,3}. Its radiation effects, therefore, have been studied because it enters the cell without becoming a part of deoxyribonucleic acid and thus provides a source of radiation outside the deoxyribonucleic acid molecule.

2-¹⁴C-Thymidine was prepared by enzymatic reaction of 2-¹⁴C-thymine with deoxyribose-1-phosphate⁴. The thymidine thus obtained, like the parent thymine, had a specific activity of 3 microcuries per micromole.

Seeds of *Allium cepa* were germinated, and placed on filter paper so that the rootlets were in contact with radioactive solutions. The root tips were stained according to the Feulgen technique, smeared, and late anaphase and early telophase cells were scored for the presence of fragments and bridges. Scoring was on the basis of percentage of aberrant cells rather than aberrations per cell. A count of cells with one or more micronuclei was made for all but a few of the root meristems studied. All root tips were coded, so that the nature of the treatment was unknown to the scorer.

A 19-hr. exposure to radiothymidine was more effective in causing chromosomal aberrations than a similar treatment with radiothymine (Table 1). Controls (water, non-radioactive thymidine, non-radioactive thymine) showed much less chromosomal damage.

The frequency of aberrant cells did not increase significantly with exposure to ¹⁴C-thymidine for periods up to 12 hr.; after 12 hr., radiation damage increased markedly with exposure, whereas increasing exposure to ¹⁴C-thymine was not so effective (Table 2).

Since thymidine was incorporated into deoxyribonucleic acid and not into ribonucleic acid, a con-

Table 1

Treatment*	Cells scored	Aberrant cells (per cent)	Av. No. of cells per meristem with micronuclei
Radiothymidine	1,093	8.41	54.1
Radiothymine	1,084	2.12	11.3
Water	1,021	0.68	4.6
Non-radioactive thymidine	330	1.21	5.0
Non-radioactive thymine	264	1.13	7.4

* All components were present at a final concentration of 0.42 μ M per ml. of water.

Table 2

Treatment (hr.)	Cells scored	Aberrant cells (per cent)	Av. No. of cells per meristem with micronuclei
Radiothymidine, 0.42 μ M per ml. (1.26 μ c. per ml.)			
4	329	2.13	5.1
8	292	2.40	13.1
12	311	2.57	15.1
16	201	5.47	26.5
20	211	14.22	61.3
24	222	15.77	83.6
28	240	13.33	107.4
30	188	20.74	135.3
Radiothymine, 0.42 μ M per ml. (1.26 μ c. per ml.)			
28	319	3.13	24.4
28	253	1.98	30.2
30	279	4.66	26.6

venient method for determining radioactivity in the former per root tip was provided. Feulgen-stained meristems, previously treated with ^{14} C-thymidine or ^{14} C-thymine for 19 hr., were smeared on copper planchets, flushed with 70 per cent alcohol and assayed in an internal flow counter. Meristems treated with radiothymidine assayed an average of 455 counts per min., in contrast to 39 counts per min. for meristems treated with radiothymine.

It is clear that radioactive thymidine causes chromosome aberrations which increase in frequency with increased exposure. This appears to be correlated with the unique localization of radioactivity in the thymine of deoxyribonucleic acid. Additional biochemical-cytological studies are now in progress; it is hoped that from these studies it may be determined whether the chromosome breaks are caused chiefly by discharges in the deoxyribonucleic acid or by β -particles from an extra-chromosomal source.

This work was supported in part by grants from the American Cancer Society.

HENRY A. MCQUADE
MORRIS FRIEDKIN
ALICE A. ATCHISON

Departments of Pharmacology and Radiology,
Washington University School of Medicine,
St. Louis 10, Missouri.

Jan. 31.

¹ Reichard, P., and Estborn, B., *J. Biol. Chem.*, **188**, 839 (1951).

² Friedkin, M., Tilson, D., and Roberts, D., *Fed. Proc.*, **13**, 214 (1954).

³ Plentl, A. A., and Schoenheimer, R., *J. Biol. Chem.*, **153**, 203 (1944).

⁴ Friedkin, M., and Roberts, D., *J. Biol. Chem.*, **207**, 257 (1954).

Creatine-Creatinine Metabolism in Radiation Myopathy

MUSCULAR weakness is one of the well-known clinical sequelae of exposure of mammals to ionizing radiation. The degree of myasthenia is determined by the radiation dose to which the individual has been exposed. The present report deals with observations which may give a clue to some of the biochemical mechanisms underlying this radiation-induced myopathy.

Concurrent with studies designed to measure radiation-induced tissue breakdown in rats exposed to 756 r. of total-body X-radiation, total amount and specific activity of the urinary creatine and creatinine was measured in animals loaded with glycine-2- ^{14} C for eight days prior to irradiation. Each of ten rats, weighing about 190 gm. at the beginning of the experiment, was injected intraperitoneally with a daily dose of 2 ml. (337 μ gm.) of glycine-2- ^{14} C giving 337,280 counts/min. for a period of eight days, that is, a total dose giving 2,698,240 counts/min. Eight hours after the last injection, six of the animals were exposed to 756 r. of 250 kV. X-rays (L.D. 75/30 days). Immediately afterwards, each rat was given an intraperitoneal injection of 10 mgm. benzoic acid in 10 ml. of 0.9 per cent sodium chloride. The rats were placed in individual confining cages and urine was collected for 24 hr. after exposure. An additional 10 mgm. of benzoic acid was given at this time, and the urine output of the second 24-hr. period was collected.

Creatinine and creatine were determined according to the method of Stelgens¹. The carbon-14 activity of total creatinine was measured by counting the activity of the appropriate area on Whatman filter paper No. 1 after conversion of creatine to creatinine and chromatography in a solvent-system consisting of butanol saturated with water². The amount and activity of hippuric acid were determined according to a previously published method³.

As a result of the loading procedure, glycine-2- ^{14} C and substances in biological equilibrium with this amino-acid were incorporated into the tissue proteins of the animals. Since the sarcosine moiety of creatine and creatinine is derived from glycine⁴, the α -carbon and the N-methyl carbon atoms of the sarcosine moiety were also labelled with radioactive carbon. The carbon-14 activity of the N-methyl carbon arises from the contribution made by the α -carbon atom of glycine to the 'methyl-carbon fragment' pool. After irradiation, the tissue proteins undergo degradation, as evidenced by an increased excretion of carbon-14 activity in urinary hippuric acid⁵. This increase in activity of the urinary hippuric acid is a reflexion of the increased radioactivity of the free glycine pool caused by breakdown of the labelled proteins. In parallel with this increase in the carbon-14 activity of the excreted hippuric acid, the creatine-creatinine carbon-14 activity of the urine of the irradiated animals also increases, especially during the second collection period (Table 1). This alteration in the urinary creatine-creatinine carbon-14 activity may be due to either (1) an increased amount of glycine labelled with carbon-14 offered to the liver for creatine synthesis, with or without diminished utilization by the muscle, or (2) release of creatine labelled with carbon-14 consequent on changes in the muscle of the irradiated animals. Experiments are now in progress to test the validity of these hypotheses.

The other noteworthy finding in these experiments is an increased excretion of creatine. This creatinuria with its high isotope concentration in the creatine-creatinine fraction resembles that found in muscular dystrophy⁶. It has also been found that creatine and creatinine in the urine of the irradiated animals have approximately the same specific activity. This suggests that urinary creatine and creatinine are derived from muscle creatine or phosphocreatine⁷.

A comparison of the specific activity of the urinary creatine-creatinine fraction (calculated as the average of the two labelled carbon atoms) with the specific

Table 1. EXCRETION AND CARBON-14 ACTIVITY OF URINARY CREATINE-CREATININE AND HIPPURIC ACID

Time interval after exposure (hr.)	Group	No. of animals (starved)	Creatine* (mgm.)	Creatinine* (mgm.)	Carbon-14 activity of combined creatinine-creatinine fraction†	Carbon-14 activity of hippuric acid‡
0-24	Control	3	27.97 (22.68-33.81)	6.12 (3.58-9.9)	6,320 (2,100-4,080)	13,270 (10,650-15,350)
	Irradiated	6	28.69 (17.53-42.22)	7.37 (4.55-10.5)	5,560 (3,600-6,580)	18,670 (11,640-25,640)
24-48	Control	4	10.12 (8.7-14.36)	12.31 (10.5-15.68)	2,470 (1,610-4,140)	11,850 (8,750-14,280)
	Irradiated	6	21.54 (16.24-27.64)	8.86 (6.8-11.2)	5,000 (4,000-9,420)	18,000 (12,080-24,500)

* Total amount excreted during the time interval studied. The figures in parentheses represent the ranges, whereas the figures above these parentheses show the average values for the group.

† Counts per min./mgm. carbon (N-methyl + α -carbon atoms of sarcosine moiety).

‡ Counts per min./mgm. carbon (methylene carbon atom of glycine residue).

activity of the α -carbon atom of N-benzoyl glycine (hippuric acid) reveals that the ratio of hippuric acid to creatine-creatinine activity is significantly lower in the irradiated animals, suggesting that some of the creatine-creatinine fraction probably is newly synthesized.

Thus it was demonstrated that total-body exposure is accompanied by creatinuria and an increased isotope concentration in the urinary creatine-creatinine fraction. These findings are thought to be related to the myasthenia occurring as result of exposure to radiation.

The work was supported in part by the U.S. Atomic Energy Commission.

G. L. HABERLAND
K. SCHREIER
F. BRUNS
K. I. ALTMAN
L. H. HEMPELMANN

Division of Experimental Radiology,
Department of Radiology,
School of Medicine and Dentistry,
University of Rochester,
Rochester, New York.
Feb. 2.

¹ Stelgens, P., *Biochem. Z.*, **324**, 228 (1953).

² Maw, G. A., *Biochem. J.*, **43**, 139 (1948).

³ Gaffney, G. W., Schreier, K., DiFerrante, N., and Altman, K. I., *J. Biol. Chem.*, **206**, 695 (1954). Haberland, G. L., Bruns, F., and Altman, K. I., *Biochim. et Biophys. Acta*, **15**, 578 (1954).

⁴ Bloch, K., and Schoenheimer, R., *J. Biol. Chem.*, **138**, 167 (1941).

⁵ Altman, K. I., Schreier, K., and Hempelmann, L. H., *Radiation Research*, **1**, 487 (1954).

⁶ Benedict, J. D., Kalinsky, J. J., Scarrone, L. A., Wertheim, A. R., and Stetten, jun., De W., *J. Clin. Invest.*, **34**, 141 (1955).

⁷ DuVigneaud, V., Cohn, M., Chandler, J. P., Schenck, J. R., and Simmonds, S., *J. Biol. Chem.*, **140**, 624 (1941). Block, K., and Schoenheimer, R., *J. Biol. Chem.*, **131**, 111 (1939). Borsook, H., and Dubnoff, J., *J. Biol. Chem.*, **168**, 493 (1947).

Protective Action of Monospecific Anti-*Brucella* Sera in Mice

MONOSPECIFIC anti-*Brucella* sera have been used in the past for serological identification of *Brucella* strains, on the basis of their property of agglutinating homologous organisms to a higher titre. It was considered of interest to determine whether these sera had immunological in addition to serological specificity—in other words, whether an absorbed anti-*Brucella abortus* serum would afford better protection against *Br. abortus* than against *Br. melitensis* and vice versa. A passive protection test in mice was employed. This test will be described in detail elsewhere (Sulitzeanu¹) and therefore only a brief description of the methods will be given here.

Groups of five mice were inoculated intramuscularly with 0.1 ml. of the 1/5 serum dilution; 18 hr. later the mice were challenged intra-abdominally, together with untreated controls, with an appropriate number of living *Brucella*. The animals were killed seven days after challenge, the spleens of each group were removed and triturated together and the number of bacteria determined by culture. The logarithm of the ratio:

Average number of bacteria per spleen of untreated mice
Average number of bacteria per spleen of passively immunized mice

(called the 'protection index') gave a measure of the protection afforded. Statistical analysis showed a difference of 0.72 between two protection indexes to be significant at the 5 per cent level.

The sera used had been prepared by inoculation of rabbits with living *Br. abortus* 544 or *Br. melitensis* 16 M, and had been absorbed with the heterologous strains in order to obtain absorbed or monospecific sera. They were, in fact, sera used at Weybridge for routine typing purposes or issue for this purpose. Agglutinating titres before and after absorption are shown in Table 1.

Both absorbed and non-absorbed sera were inoculated into mice and the results are summarized in Table 2. It is clearly seen that the latter protected the animals against both strains, whereas the former

Table 1. AGGLOUTINATING TITRES

Serum	Antigen	
	<i>abortus</i>	<i>melitensis</i>
Anti- <i>abortus</i> , before absorption	5,120	5,120
Anti- <i>abortus</i> , after absorption	320	0
Anti- <i>melitensis</i> , before absorption	5,120	5,120
Anti- <i>melitensis</i> , after absorption	0	320

Table 2. SPLEEN COUNTS AND PROTECTION INDEXES OF PASSIVELY IMMUNIZED MICE

Challenge strains were *Br. abortus* S.19 and *Br. melitensis* 16 M

1/5 dilution of serum	Challenge dose	Challenge strain	Spleen count	Protection index
Non-absorbed anti- <i>abortus</i>	2.8 × 10 ⁴	S.19	100	4.06
Absorbed anti- <i>abortus</i>	"	"	33	4.54
Non-absorbed anti- <i>melitensis</i>	"	"	133	3.94
Absorbed anti- <i>melitensis</i>	"	"	483,000	0.38
No serum	"	"	1,150,000	
Non-absorbed anti- <i>melitensis</i>	1.8 × 10 ⁴	16 M	6,100	1.93
Absorbed anti- <i>melitensis</i>	"	"	7,500	1.84
Non-absorbed anti- <i>abortus</i>	"	"	2,250	2.36
Absorbed anti- <i>abortus</i>	"	"	36,100	1.16
No serum	"	"	521,000	

either protected only against the homologous challenge (*melitensis* serum) or protected better against homologous challenge (*abortus* serum).

D. SULTZEANU

Department of Bacteriology,
Hebrew University,
Jerusalem.

L. JONES

A. W. STABLEFORTH

Veterinary Laboratory,
New Haw,
Weybridge, Surrey.
Feb. 17.

¹ Sultzeanu, D., *J. Hyg.* (in the press).

Microbiological Determination of Free Amino-Acids in the Body Fluid of the Silkworm Larva (*Bombyx mori*)

THE kinds of free amino-acids present in the body fluid of the silkworm larva have been determined by paper chromatography¹, but little is known of the quantities present. The present work was carried out to determine the concentrations of individual free amino-acid by microbiological assay.

Material was obtained from the silkworm, *Sz* 108 (*Kyu*), at the third and sixth days of the 5th instar (51 and 124 hr. from the commencement of the feeding period). The feeding period of the 5th instar was about 148 hr. The method of preparing the samples for microbiological assay was, in principle, that described by Elvehjem *et al.*² for the assay of rat blood plasma except for the precipitating agent. The precipitation of the proteins in the body fluid was carried out with trichloroacetic acid instead of tungstic acid as a precipitating agent, because free amino-acids in the body fluid, especially some of the basic amino-acids, such as histidine and lysine, which are precipitated with the protein by using tungstic acid according to the procedure of Elvehjem *et al.*, are not precipitated by using trichloroacetic acid³. 10 ml. of the body fluid which was collected in a tube kept in ice-water was added to a bottle containing 90 ml. of 3 per cent trichloroacetic acid, and the bottle and contents allowed to stand at room temperature for 30 min. with intermittent shaking. The precipitates were removed by centrifugation, and the filtrates were heated in a boiling water-bath for a few minutes. The clear protein-free filtrates were adjusted to pH 6.8 with *N* sodium hydroxide, made up to 100 ml. with the distilled water and stored in a refrigerator under toluene until determinations were carried out. The microbiological assays on seventeen free amino-acids in the trichloroacetic acid filtrates were carried out by the procedures described by Tamura *et al.*⁴. The 100- to 400-fold dilutions of the fresh body fluid were suitable for determining the majority of the amino-acids except histidine (400- to 2,000-fold dilutions).

The concentrations of free amino-acids in the body fluid are summarized in Table 1. Recovery of amino-acids added to the trichloroacetic acid filtrates was 90-110 per cent in most cases. The individual free amino-acid concentrations in the body fluid obtained by using tungstic acid as the precipitating agent were, except for the basic amino-acids, in good agreement with those obtained by using trichloroacetic acid. The concentrations of the individual free amino-acids in the body fluid on the sixth day of

Table 1. CONCENTRATIONS OF FREE AMINO-ACIDS IN THE BODY FLUID (Values in $\mu\text{gm. per ml.}$)

Amino-acids	Body fluid of the silkworm		Organism*	Human blood plasma (Bergeim <i>et al.</i> , ref. 7)	Rat blood plasma (Elvehjem <i>et al.</i> , ref. 6)
	Third day of 5th instar	Sixth day of 5th instar			
Alanine	305	176	<i>Cit</i>		
Arginine	356	210	<i>M</i>	16	32
Aspartic acid	60	240	<i>M</i>		
Glutamic acid	90	175	<i>S</i>		
Glycine	284	129	<i>M</i>		23
Histidine	2,199	2,805	<i>Cit</i>	14	10
Isoleucine	75	46	<i>M</i>	13	13
Leucine	153	116	<i>M</i>	19	27
Lysine	889	1,042	<i>M</i>	22	58*
Methionine	97	78	<i>M</i>	5	10
Phenylalanine	73	96	<i>M</i>	10	14
Proline	103	104	<i>Cit</i>		43
Serine	201	483	<i>M</i>		
Threonine	314	237	<i>S</i>	17	44
Tryptophan	32	52	<i>M</i>	13	17
Tyrosine	279	202	<i>M</i>	10	22
Valine	255	138	<i>M</i>	27	27

* *Cit* = *Leuconostoc citrovorum*; *M* = *Leuconostoc mesenteroides*; *S* = *Streptococcus faecalis*.

the 5th instar were found; histidine and lysine (more than 1,000 $\mu\text{gm./ml.}$), were very high; serine, aspartic acid, threonine, arginine, tyrosine, alanine, glutamic acid, valine, glycine, leucine and proline (460-100 $\mu\text{gm./ml.}$) came next; and phenylalanine, methionine, tryptophan and isoleucine (less than 100 $\mu\text{gm./ml.}$) were comparatively low. A somewhat similar value was also observed in body fluid of the third day of the 5th instar. Except for tyrosine⁵, body fluid concentrations of the other individual free amino-acid shown here have apparently not been reported.

In general, the concentrations of the individual free amino-acid in the body fluid of silkworm larvae are strikingly different from those of the rat⁶ and of human blood plasma⁷ (Table 1); a particular feature is the much higher concentrations of basic amino-acids, such as histidine and lysine.

T. FUKUDA
J. KIRIMURA
M. MATUDA
T. SUZUKI

Sericultural Experiment Station,
Tokyo.
Feb. 3.

- ¹ Andrée, D., and René-Huy, B., *Rev. Ver. et Soie*, 51 (1949). Fukuda, T., *Bull. Sericul. Exp. Sta.*, 13, 481 (1951).
- ² Schurr, P. E., Thompson, H. T., Henderson, L. M., and Elvehjem, C. A., *J. Biol. Chem.*, 182, 29 (1950).
- ³ Fukuda, T., Kirimura, J., Matuda, M., and Suzuki, T., *J. Sericul. Sci. Japan* (in the press).
- ⁴ Tamura, C., Tsunoda, T., Kirimura, J., and Miyazawa, S., *J. Agric. Chem. Soc. Japan*, 26, 464 (1952).
- ⁵ Fukuda, T., *Bull. Sericul. Exp. Sta.*, 13, 423 (1951).
- ⁶ Henderson, L. M., Schurr, P. E., and Elvehjem, C. A., *J. Biol. Chem.*, 177, 815 (1949).
- ⁷ Johnson, C. A., and Bergeim, O., *J. Biol. Chem.*, 188, 833 (1951).

Preparation of Metallic Isotopic Targets of the Alkali and Alkaline Earth Metals by Evaporation of their Compounds

ELECTROMAGNETICALLY enriched isotopes of the elements lithium, potassium, rubidium, calcium, strontium and barium, after the necessary chemical processing, are only available in one of the standard gravimetric forms, whereas nuclear targets for reaction studies in high-voltage accelerators are

usually required as the element. It is scarcely feasible on the milligram scale to prepare the elements for evaporation; but the following simple method of making the targets is very successful. The oxide or carbonate of the isotopic element is pasted on to a boat composed of a strip of tantalum; this is directly heated in high vacuum, when oxide is reduced and the metal evaporates so that targets can be deposited using a cooled assembly. By control of the rate of heating and with suitable geometry, it is possible to achieve more than 50 per cent deposition on the backing, while the remainder of the evaporated material is recoverable. The target is then transferred to a tube which is stoppered while under vacuum and sealed off. When the target is required for use, it can be transferred to the accelerator without undue exposure to air. Alternatively, the target can be warmed in hydrogen or its isotopes to give the more stable hydrides. Deposits from a few micrograms to 1 mgm./cm.² on a variety of backings are readily made.

The use of a tantalum boat was originally suggested by Russell *et al.*¹ for reduction of magnesium oxide to give isotopic magnesium targets.

D. H. RANDALL
M. L. SMITH

Atomic Energy Research Establishment,
Harwell, Berks.
April 1.

¹ Russell, L. N., Taylor, W. E., and Cooper, J. N., *Rev. Sci. Instr.*, 23, 764 (1952).

Scintillation Techniques for the Detection of Natural Radiocarbon

THE development of liquid scintillators of high pulse-height efficiency has made possible a new technique for the determination of natural radiocarbon. If the carbon content of the sample can be incorporated into a liquid scintillator, a detector of high sensitivity and excellent geometry is inherently present, and the detector volume is reduced considerably in comparison with that of the screen-wall counter¹, thus lowering the background counting-rate. The synthesis of a suitable compound which can function directly as solvent or diluent is necessary for this method.

In this communication the synthesis and use of toluene as the solvent in a liquid scintillator is described. The synthesis of toluene containing seven sample carbon atoms per molecule appeared possible but impractical for routine work. Instead, the simpler expedient of incorporating sample carbon into only the alkyl group of the molecule appeared more feasible. This, of course, involved the dilution of the sample carbon to 1 atom in 7. Nevertheless, since this reduction is intermolecular, no quenching of the scintillations is involved such as may be encountered when different molecular species are used.

The problem of background counting-rate required careful attention. A massive lead and mercury shield was constructed, weighing approximately one ton, and with a wall thickness of 5 in. of lead and 1½ in. of mercury. The liquid scintillation cell (volume 20 c.c.) was mounted inside this shield on a selected DuMont K1190 photomultiplier of cathode diameter 1 in. The photomultiplier pulses passed to a high gain ($\times 4,000$) non-overload amplifier via a cathode

follower, and then to a wide-band differential discriminator and scaler. The differential discriminator made use of the proportional property of the scintillation counter by selecting only those pulses in the range of the energies corresponding to the β -spectrum of carbon-14. In this way a further reduction in the background counting-rate was achieved, as most γ - and cosmic-ray pulses were obviously rejected. The energy 'gate' selected was the range 40–100 keV., to include the carbon-14 β -distribution maximum, and at the same time eliminate all thermal noise from the photomultiplier tube. The carbon-14 β -ray efficiency obtained in this way was approximately 50 per cent. With a 20-c.c. 'old' toluene scintillator of petrochemical origin containing 4 gm. per litre of terphenyl and 1.0 gm. per litre of 2,5-diphenyloxazole, and freed from oxygen², the average of two 24-hr. counts gave a counting-rate of 3.34 ± 0.03 counts per min. This 'background' was regarded as entirely satisfactory for the testing of the new method, and so no attempt was made to incorporate cooling of the photomultiplier or anticoincidence shielding at this stage. The necessity for this shielding was almost entirely eliminated by the pulse-height sorting technique. The residual counting-rate of 3.34 counts/min. was due to (1) the rare cosmic-ray event which dissipates energy in the range of 40–100 keV. in the liquid; (2) γ -radiation which has been scattered in the shield until its energy is in the same range; (3) trace contamination of the materials of the photomultiplier and glass cell; (4) a long 'tail' on the photomultiplier 'noise' curve, possibly due in part to extremely rare cosmic- and γ -ray interactions with the materials of the photomultiplier.

The synthesis of a toluene sample containing modern carbon was carried out as follows. The sample was burned in a 'Vycor' combustion tube, and the carbon dioxide evolved was trapped in a solution of barium hydroxide. After washing and filtration, the barium carbonate was treated with perchloric acid to regenerate the carbon dioxide at a rate which was automatically controlled to correspond to its rate of absorption in a Grignard reaction to form benzoic acid. In other respects the procedure was similar to that recently reported for the preparation of labelled benzoic acid³. One gm.-mole of barium carbonate was employed, and a yield of 80 per cent based on carbon dioxide was obtained. The reduction of benzoic acid to benzyl alcohol was performed in a diethyl ether solution employing lithium aluminium hydride⁴ as a reducing agent. A yield of 90 per cent was obtained. The benzyl alcohol was brominated with phosphorus and bromine in 75 per cent yield. The benzyl bromide was then converted to toluene with lithium aluminium hydride⁵.

The 'modern' toluene obtained from this synthesis was then mixed with 'old' toluene to simulate samples of 16,800 years, 24,800 years and 35,000 years. The net sample counting-rates were determined to be 1.86 ± 0.04 , 0.94 ± 0.04 and 0.30 ± 0.04 counts/min., respectively, based on the average of two 24-hr. counts in each case. Fig. 1 shows the results of these measurements, and indicates that the counting-rates are consistent and agree within statistical error. From the accepted half-life of carbon-14 and the known amounts of 'modern' carbon present, it was estimated that the carbon-14 counting efficiency was approximately 50 per cent.

It is evident from Fig. 1 that results of significance can be obtained for ages as great as 45,000 years with samples of the volume used here, and a counting

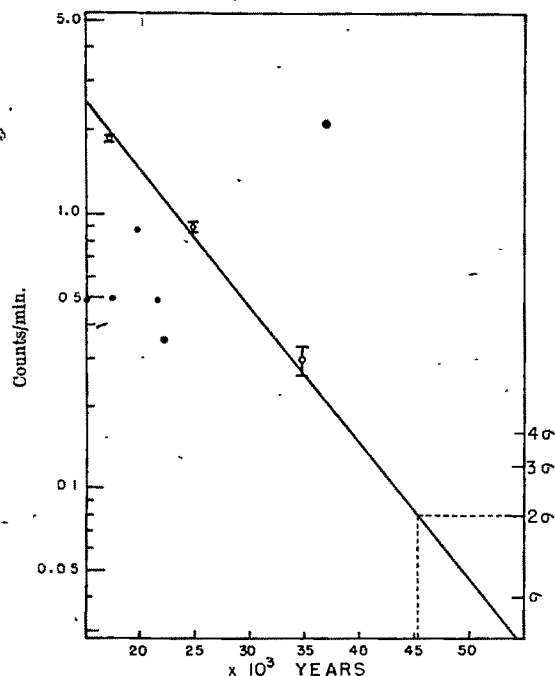


Fig. 1. Counting-rate plotted against age of sample for three 20-a.c. samples of 16,800, 24,800 and 35,000 years, respectively. The standard deviation σ of the background, for a 2-day count, is shown. It is evident that a 45,000-year sample will give an effect twice as large as the standard deviation of the background count

period of two to three days. Our results are shown in Table 1, together with comparable results (collected by Arnold⁶) for other methods.

The results of this investigation show that a liquid-scintillation counter employing toluene from sample carbon as the solvent can be utilized for carbon-14 age determinations, with a single uncooled photomultiplier tube. The present synthesis, however, is somewhat involved for routine measurements of large numbers of samples. Further work in our laboratories on a simple synthesis of methanol from carbon dioxide shows considerable promise for development of a routine liquid scintillator technique for age determination⁸, giving results comparable to those described above. Dr. J. R. Arnold⁶, in an independent investigation, has proposed the use of liquid scintillator techniques, but has used a more complicated counting assembly which appears to

give a somewhat higher background, even when due allowance is made for his larger cell volume.

We are indebted to the Wenner-Gren Foundation for support of this work, and to the National Research Council of Canada for a grant-in-aid covering certain aspects of the investigation.

B. L. FUNT
S. SOBERING

Department of Chemistry,

R. W. PRINGLE
W. TURCHINETZ

Department of Physics,
University of Manitoba,
Winnipeg,
Dec. 14.

- ¹ Libby, W. F., "Radiocarbon Dating" (Univ. Chicago Press, Ill., 1952).
- ² Pringle, R. W., Funt, B. L., Black, L. D., and Sobering S., *Phys. Rev.*, **92**, 1582 (1953). Hayes, F. N., and Gould, R. G., *Science*, **117**, 480 (1953).
- ³ Dauben, W. G., Reid, J. C., and Yankwich, P. E., *Anal. Chem.*, **19**, 528 (1947).
- ⁴ Nystrom, B. F., and Brown, W. G., *J. Amer. Chem. Soc.*, **69**, 2548 (1947).
- ⁵ Johnson, J. E., Blizarc, R. H., and Carhart, A. W., *J. Amer. Chem. Soc.*, **70**, 3664 (1948).
- ⁶ Arnold, J. R., *Science*, **119**, 155 (1954).
- ⁷ Crathorn, A. R., *Nature*, **172**, 632 (1953).
- ⁸ Pringle, R. W., Turchinets, W., and Funt, B. L., *Rev. Sci. Instr.* (in the press).

Chemical Effects associated with 'Colour Centres' in Alkali Halides

MEASUREMENTS of the chemical effects of colour centres have previously been made on additively coloured crystals^{1,2} and on crystals irradiated with X-rays^{3,4}. The usual method of measuring electron-excess centres has been to follow the change of pH which occurs on dissolving the crystals in water, due to the reaction $e + H_2O = \frac{1}{2}H_2 + OH^-$. This method is subject to errors due to the variable carbon dioxide content of solutions; and large effects have been reported with untreated material². We have found that measurement of the gas evolved on dissolution of a treated crystal in carefully degassed water can be used successfully. Analysis of the gas in a Blacet-Leighton micro-apparatus always revealed 95-99 per cent hydrogen present. This method entails no uncertainties due to solution effects, and blank results were always obtained with untreated crystals. It can be applied most easily to concentrations of centres in the region of 10^{18} per cm.³ produced either by additive coloration or by ionizing radiation. Direct comparison of this chemical effect with the optical absorption of the *F*-band in additively coloured crystals is difficult at these concentrations, since very thin sections are required, and an appreciable concentration of other centres is usually present. However, work is in progress to correlate the optical and chemical effects of additively coloured crystals in carefully chosen specimens, so that further comparison may be made with irradiated crystals.

Electron defect centres have been measured⁴ in irradiated sodium chloride crystals by using the o-tolidine reagent for measuring the 'free chlorine' content of solutions produced by dissolving the crystal in water. We have used this method and another based upon the oxidation of I^- to free iodine, measured spectrophotometrically as I_3^- in buffered solution⁵. Both methods gave similar results on the same sample of irradiated sodium chloride; but the iodometric

Table 1

	Screen wall counter (ref. 1)	Gas counter (ref. 7) (acetylene)	33 per cent ethanol scintillation counter (ref. 6) (100-ml. cell)	Toluene scintillation counter (20-ml. cell)
Sample size (gm.)	8	3	14.2	2.2
Counting efficiency (per cent)	5.4	75	25	50
Net sample counting-rate (contemporary carbon (counts/min.))	6.7	34.5	54	16
Background counting-rate (counts/min.)	4.0	30.0	26	3.3

method was generally more reliable and proved easier to standardize.

Irradiations of sodium chloride crystals were carried out using a 5 μ amp. target-current of 1.25 MV. electrons from a Van de Graaff generator. Relatively large concentrations of centres ($5 \times 10^{17} - 2 \times 10^{18}/\text{cm}^3$) could be produced depending on irradiation conditions, and chemical effects were easily measured on specimens down to 10 mgm. in weight. The following results have been observed.

(1) Stability of centres. A sample of irradiated sodium chloride ground up to give a homogeneous mass gave the same analysis based on oxidizing power over a period of four weeks, being kept dry and in daylight throughout.

(2) Analyses by the methods discussed above showed that, on the same sample, electron excess and defect concentrations were equivalent. A previous explanation⁶ of the stability of the *F*-centres produced by electrons was that chlorine, presumably equivalent to the number of *F*-centres, escaped from the crystal. Our results, plus the fact that these crystals can be bleached entirely by heating to 250° C., are in keeping with the mechanism proposed recently by Varley⁷, but can also be explained on the model of a stable *V*₃ centre, proposed by Seitz⁸.

(3) If a crystal was kept at room temperature by cooling with an air blast during irradiation, measurements showed that after 20 min. a reproducible saturation value of 7×10^{17} centres/cm.³ was reached. Fig. 1 shows the absorption spectrum of such a crystal, indicating the formation of well-defined *F*- and *M*-bands.

(4) Without the cooling effect of an air blast, the crystal became distinctly warm under irradiation at the same intensity, and a large increase in the number of centres became noticeable. After 2-3 hr. continuous irradiation, concentrations of centres up to $2 \times 10^{18}/\text{cm}^3$ were measured and the crystal became blue in colour. Fig. 2 shows the absorption spectrum of such a crystal, and it is seen that a new band is now present instead of the *F*- and *M*-bands found previously. The absorption spectrum of an additively coloured sodium chloride crystal is also included in the diagram. The main band appears to be the colloidal band described by Scott, Smith and Thompson⁹, which has also been obtained in irradiated samples by Westervelt (see discussion, ref. 9), while the small band at 400 m μ may be analogous to the band of wave-length rather shorter than that

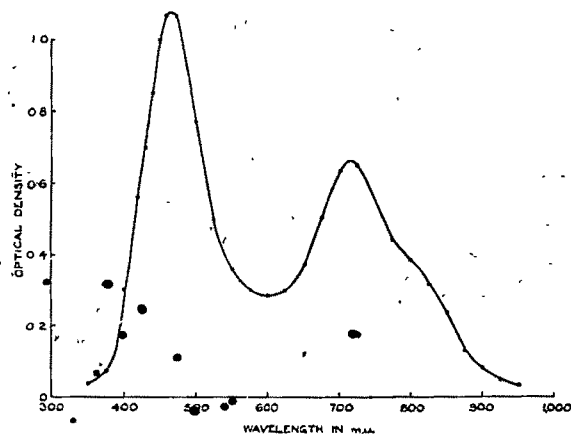


Fig. 1. Sodium chloride doped to saturation at room temperature; 1.25 MV., 5 μ amp. Measured at room temperature. Thickness 0.00626 cm.

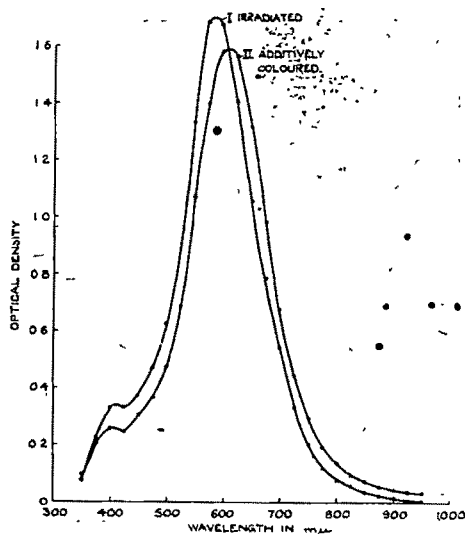


Fig. 2. I, sodium chloride irradiated hot, 1.25 MV., 5 μ amp. for 2½ hr. Thickness, 0.00246 cm. II, sodium chloride heated with sodium at 650° C. Thickness, 0.103 cm. Both measured at room temperature

of the *F*-band found in potassium iodide containing excess metal.

(5) It has been found that crystals of sodium chloride containing high concentrations of colour centres produced by electron irradiation are able to initiate the polymerization of acrylonitrile in aqueous solution. This effect is not observed with unirradiated crystals, nor with additively coloured specimens; it can only be explained on the assumption that free atoms are produced by irradiation within the crystal, which become available for chemical reaction on dissolution in water.

Earlier experiments with electron irradiated pellets of compacted caesium chloride powder gave similar results for chemical determinations to those described above. Again the highest concentration measured was $\sim 2 \times 10^{18}$ centres/cm.³. Mr. T. H. Bates, of this laboratory, has also carried out measurements on several alkali halides (sodium chloride, potassium chloride, caesium chloride, potassium bromide, potassium iodide) irradiated in a kilocurie cobalt-60 γ -source for periods up to 20 hr. Chemical changes due to the production of free halogen atoms were observed as before, although the scale of effects was reduced.

This work will be reported in full elsewhere. Our thanks are due to Mr. J. D. Milne and Mr. B. Morris, who kindly operated the Van de Graaff machine during the irradiations.

W. G. BURNS
T. F. WILLIAMS

Chemistry Division,
Atomic Energy Research Establishment,
Harwell, Didcot, Berks.
Jan. 19.

¹ Kleinschrod, F. G., *Ann. der Phys.*, (5), 27, 97 (1936).

² Scott, A. B., and Smith, W. A., *Phys. Rev.*, 83, 982 (1951).

³ Hacksaylo, M., and Otterson, D., *J. Chem. Phys.*, 21, 552 (1953).

⁴ Hacksaylo, M., and Otterson, D., *J. Chem. Phys.*, 21, 1434 (1953).

⁵ Allen, A. O., Hoehenadel, O. J., Ghormley, J. A., and Davis, T. W., *J. Phys. Chem.*, 56, 575 (1952).

⁶ Mott, N. F., and Gurney, R. W., "Electronic Processes in Ionic Crystals", 112 (Oxf. Univ. Press, 1946).

⁷ Varley, J. H. O., *Nature*, 174, 886 (1954).

⁸ Seitz, F., *Rev. Mod. Phys.*, 28, 7 (1954).

⁹ Scott, A. B., Smith, W. A., and Thompson, M. A., *J. Phys. Chem.*, 57, 757 (1953).

Structure of Native and Mercerized Celluloses

THE crystal unit-cells proposed by K. Meyer and H. Mark¹ and K. Meyer and L. Mish² for cellulose lattices I and II, and for which there seemed to be general agreement,³ have been discussed recently by M. K. Sen and S. C. Roy³. These authors have given a new interpretation to X-ray diagrams obtained from these fibres, based on the existence of a strong diffraction intensity corresponding to a reticular distance of the order of 14 Å. This interference result had hitherto not been observed for these substances. This new interpretation has been considered with certain reservations by G. O. Warwick and H. J. Vellard⁴, who have pointed out the causes of errors already remarked upon by other investigators. H. J. Woods⁵, on the other hand, has observed a small-angle spot for jute very near that observed by Sen and Roy.

It seemed worth while to us to repeat this work on a group of textile fibres (ramie, viscose, linen, 'Fortisan', etc.) using experimental techniques beyond criticism.

X-ray diagrams were obtained with a diffraction camera which was designed especially for fibre studies⁶. In brief, the film is placed in a vacuum, the X-ray beam coming from a copper anticathode is monochromatized by reflexion from a curved quartz crystal, and the focalization is exact for all angles within the equatorial plane (Guinier⁷).

The diffraction diagrams may be obtained up to approximately 20 Å. Furthermore, the mounting of a double monochromator⁸ in a vacuum, making it possible to obtain diagrams at very small angles, permits us to record the diffraction from 200 Å. up to reticular distances corresponding to intense equatorial interferences of the cellulose fibres (101) and (10 $\bar{1}$), or (101) for mercerized cellulose. Diagrams were obtained using samples that were dried as much as possible and then afterwards humidified.

In every case no reflexion corresponding to a reticular distance of 14 Å. could be observed. Only jute (an imperfectly delignified sample) gave an equatorial spot corresponding to 14 Å.; but its intensity was very weak (4 or 5 per cent of the intensity of (101) at the very most).

The perfect agreement of the results obtained by means of the use of two complementary methods indicated that, for the group of cellulose fibres, the interference observed by Sen and Roy could not be repeated. In the case of jute the purity of the cellulose must be challenged.

As a result it appears that the customary interpretation of fibre photographs will not have to be modified. On the other hand, we have succeeded in demonstrating that, under certain faulty experimental conditions, it is possible to observe aberrant reflexions. Thus by irradiating the fibres with a

beam from a tube having a chromium anode, we have observed the spots noted by Sen and Roy. Moreover, monochromatization of the beam caused these spots to disappear. This proves that in the case of substances which are as badly crystallized as the textile samples, one must give special attention to experimental techniques, and in particular to the composition of the X-ray beam used.

C. LEGRAND
A. BONNEMAYEE
Institut Textile de France.

A. GUINIER
P. ANTZENBERGER
Conservatoire des Arts
et Métiers.

¹ Meyer, K., and Mark, H., *Z. phys. Chem.*, B, 115 (1929).

² Meyer, K., and Mish, L., *Helv. Chim. Acta*, 20, 234 (1937).

³ Sen, M. K., and Roy, S. C., *Nature*, 173, 298 (1954).

⁴ Warwick, G. O., *Nature*, 174, 135 (1954). Vellard, H. J., *Nature*, 174, 135 (1954).

⁵ Woods, H. J., *Nature*, 174, 136 (1954).

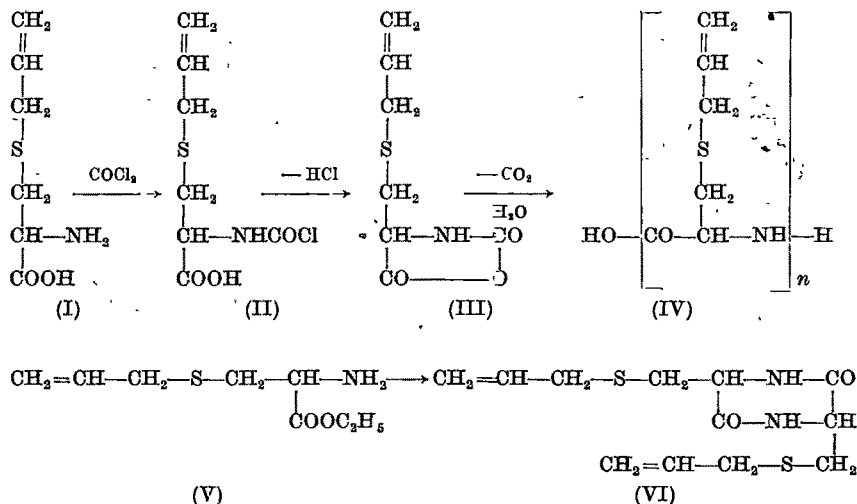
⁶ Legrand, C., *J. Polymer Sci.*, 8, 3, 337 (1952).

⁷ Guinier, A., *Ann. de Phys.*, 12, 161 (1939).

⁸ Fournet, G., and Guinier, A., *C.R. Acad. Sci., Paris*, 228, 656 (1948).

Synthesis of Poly-S-Allylcysteine (Poly-Deoxo-Alliin)

WE wish to report briefly on the synthesis of poly-S-allylcysteine (IV) (poly-deoxo-alliin), from 1-S-allylcysteine (I), by the route indicated in the scheme:



1-S-Allylcysteine, prepared according to Stoll and Seebeck¹, yielded the appropriate N-carboxyanhydride (III), via the intermediary chloride (II), on passing phosgene for about two hours at 60° through a suspension in dry dioxane. The solution was evaporated *in vacuo* at 40° and the residue kept overnight in a vacuum desiccator over phosphorus pentoxide. The remaining crystalline mass (melting point about 50°) was recrystallized from dry ethylacetate-petroleum ether, and the pure N-carboxyanhydride (III) melted at 55° with resolidification at about 115°.

Polymerization of (III) was carried out either in solution or in bulk in high vacuum. Pyridine, dioxane (with the addition of a trace of water when working in the cold or dry if heating to about 100°), glacial acetic acid or ethanol was used as solvent. On heating in bulk in a high vacuum, actual polymerization took place only on raising the temperature considerably above the melting point of (III)—at about 150°; at temperatures of about 100–105°.

unchanged Leuchs anhydride was recovered. In its solutions, the anhydride is much less stable and polymerization takes place readily, especially on heating.

The purified polymers obtained give a biuret reaction on prolonged standing; they are practically insoluble in the usual solvents, including dilute acids and alkali, but partly soluble in anhydric formic acid, glacial acetic acid, dimethyl formamide and dichloroacetic acid.

In the course of the present experiments the diketopiperazine derivative (VI) was also obtained from the ethyl ester (V).

The experiments described here are part of an investigation on the polymerization of amino-acids and their derivatives, containing unsaturated bonds, the results of which will be published at a later date.

MAX FRANKEL
ALBERT ZILKHA

Department of Organic Chemistry,
The Hebrew University,
Jerusalem. Jan. 25.

¹ Stoll, A., and Seebeck, E., *Helv. Chim. Acta*, 31, 189 (1948)

Proof of the Heisenberg Relations

SINCE Heisenberg's uncertainty relations play an essential part in quantum mechanics, especially in the discussion of the dual wave-particle aspect of matter, the derivation of these relations is of importance. We became interested in this problem in connexion with a lecture course on quantum mechanics given by one of us. In this course we wished to give a derivation of the Heisenberg relations which was rigorous without, however, involving commutator relations.

In the literature we found that, of the many textbooks in the field, some give only an outline of a proof, some give a qualitative proof based on the analogy between wave mechanics and optics, using the properties of wave trains, some use commutator relations, while Moyal¹ and Weyl use the Schwartz inequality. The well-known proof due to Heisenberg², which is also given by Pauli and Rojanski, is the kind of proof we had in mind. Unfortunately, this proof is not completely rigorous, and it is the object of this communication to modify Heisenberg's proof slightly to make it so.

Restricting ourselves to the discussion of the one-dimensional case, let $\psi(x)$ be the normalized wave function of the electron with its Fourier expansion,

$$\psi(x) = \int A(\sigma) \exp(2\pi i \sigma x) d\sigma \quad (1)$$

where x is the position of the electron, and σ the wave number. We have from equation (1),

$$A(\sigma) = \int \psi \exp(-2\pi i \sigma x) dx \quad (2)$$

We introduce now the mean position, x_0 , the mean wave number, σ_0 , the uncertainty in position, Δx , and the uncertainty in wave number, $\Delta \sigma$, by the equations,

$$x_0 = \int x |\psi|^2 dx, \quad \sigma_0 = \int \sigma |A|^2 d\sigma, \\ \Delta x^2 = \int (x - x_0)^2 |\psi|^2 dx, \quad \Delta \sigma^2 = \int (\sigma - \sigma_0)^2 |A|^2 d\sigma \quad (3)$$

We choose the origin of the x and σ scales in such a way that $x_0 = \sigma_0 = 0$, so that the last two equations (3) become

$$\Delta x^2 = \int x^2 |\psi|^2 dx,$$

$$\Delta \sigma^2 = \int \sigma^2 |A|^2 d\sigma = (4\pi)^{-2} \int \left(\frac{\partial \psi}{\partial x} \right)^2 dx \quad (4)$$

the last equation following in the usual way.

It is clear that the following inequality will always hold, irrespective of the choice of constant a :

$$|ax\psi + (\partial\psi/\partial x)|^2 \geq 0 \quad (5)$$

From expression (5) it follows by the usual analysis that

$$a^2 \Delta x^2 + 4\pi^2 \Delta \sigma^2 \geq a \quad (6)$$

At this point, Heisenberg puts $a = (2\Delta x^2)^{-1}$ and thus obtains the Heisenberg relations. There is, however, no obvious reason for this choice of a , and by choosing a different value one could derive relations between Δx and $\Delta \sigma$ which would be completely different from the Heisenberg relations.

The proof of the Heisenberg relations, however, can be completed in the following way. From inequality (6) we see that the smaller Δx^2 is, the larger, in general, will be $\Delta \sigma^2$ and that the smallest combination occurs when the equality sign holds, that is, when ψ satisfies the equation,

$$ax\psi + (\partial\psi/\partial x) = 0 \quad (7)$$

The wave function satisfying equation (7) is of the Gaussian form and a is now related to Δx^2 by the equation $a = (2\Delta x^2)^{-1}$; but this is not necessarily true for a different form of ψ . Substituting this value of a into equation (6), we get,

$$\Delta \sigma \Delta x = 1/4\pi \quad (8)$$

and since the situation is less favourable when ψ does not satisfy equation (7), we get in general $\Delta \sigma \Delta x \geq 1/4\pi$ as before.

D. TER HAAR
W. M. NICOL

Department of Natural Philosophy,
University, St. Andrews.
Jan. 19.

¹ Moyal, J. E., *Proc. Camb. Phil. Soc.*, 45, 119 (1949).

² Heisenberg, W., "Die Physikalischen Prinzipien der Quantentheorie" (Hirzel Verlag, Leipzig, 1930).

Germination of Rice Embryo under Water and its Relation of Growth to Endosperm Fractions

IT is a well-known fact that rice seeds are capable of germination under water and the coleoptile of the rice embryo grows more rapidly and more extensively under water than in air. Yamada¹ suggested that the superior growth of the rice coleoptile under water is due to the decreased capacity of the coleoptile tissue for destroying auxin under water as compared to the extensive capacity of the tissue for destroying auxin in air. Sircar and Das² have shown that the auxin of the rice endosperm gradually decreases with the growth of the coleoptile and root; such gradual consumption of auxin is stopped abruptly when the embryo is detached from the endosperm.

It has been observed that some factor present in the endosperm has a distinct inhibitory effect on the growth of the rice embryo kept under water or grown in air. Experiments were carried out with husked rice grain (variety Bhasamanik) from which different fractions of endosperm were removed, kept under water and on agar slopes in air in darkness at 25°C.

Table 1. GROWTH OF RICE EMBRYO (VAR. BHASAMANTIK) KEPT UNDER WATER AND IN AIR, 144 HR. OLD AT 25° C. IN DARKNESS

	Under water			In air		
	Mesocotyl (mm.)	Coleoptile (mm.)	Root (mm.)	Mesocotyl (mm.)	Coleoptile (mm.)	Root (mm.)
Embryo with full endosperm	nil	34.5	0.1	45.8	7.0	58.4
Embryo with $\frac{1}{2}$ endosperm	nil	35.0	0.4	43.8	7.2	70.2
Embryo with $\frac{1}{4}$ endosperm	nil	51.3	1.5	41.3	7.4	61.3
Embryo with $\frac{1}{8}$ endosperm	nil	18.2	nil	20.0	6.0	37.1

It is evident from Table 1 that the coleoptile of submerged embryos and the root growth of air-grown embryos have been accelerated by the elimination of a portion of endosperm. When more than half the endosperm was removed, no such effect of acceleration was observed. Under water, the growth of root and second leaf is almost completely suppressed, the hollow coleoptile elongates by its tapering end and it never breaks open. In complete darkness the germination of rice seed under water is significantly inferior to that in light (even so little as one or two minutes exposure in every twenty-four hours). In darkness, suppression of the mesocotyl growth of the submerged embryo is another interesting contrast to the much elongated mesocotyl of air-grown embryos.

Germination of oat seedlings under constant illumination results in the suppression of growth of the mesocotyl. The reasons for this are not well understood. Van Overbeek³ has stated: "The growth of the mesocotyl is quite dependent on the amount of auxin left over by the coleoptile. If this amount is large, a large growth will result; if the amount is small, then little mesocotyl growth will result". Galston and Baker⁴ have shown that the suppression of growth of pea epicotyl is due to the deactivation of auxin by light in the presence of riboflavin. Yamada¹ has suggested that, under water, deactivation of auxin is less and hence the length of the coleoptile is greater; but there is no reason for the suppression of the rice mesocotyl, which should not occur if the deactivation of auxin is decreased. Further, growth of the coleoptile is found to be still higher when half the endosperm is eliminated and the coleoptile presumably supplied with less auxin either in the active state or in the form of a precursor. The reasons for the acceleration of growth by elimination of endosperm fractions are not clear.

It may be presumed that the amount of auxin or some unknown factor present in the rice endosperm is more than optimal for the early growth of the embryo; hence elimination of a fraction of endosperm makes the level of auxin or the unknown factor optimal for embryo growth, until such elimination reaches a limiting value. Compared with the control (embryo with full endosperm and without added auxin), it has also been found that, on addition of indolylacetic acid to the growing embryo with three-quarters endosperm, acceleration effects on root growth were not observed. Coleoptile tip also plays an important part in the production of auxin in the embryo, for Das⁵ has shown that excised embryo of rye can produce its own auxin without the intervention of endosperm. It appears that the whole problem is complex and more work is required on the nature of transport of auxin from the endosperm of the embryo, the quantity produced by the coleoptile

itself and lastly how the growth of different parts of the embryo are regulated under different conditions.

Further work is in progress and the results will be published shortly. We thank Dr. I. Banerjee, head of the Department of Botany, University of Calcutta, for facilities for this investigation.

S. M. SIRCAR
T. M. DAS
A. N. LAHIRI

Department of Botany,
University of Calcutta.
Feb. 1.

¹ Yamada, N., *Plant Physiol.*, 29, 92 (1954).

² Sircar, S. M., and Das, T. M., *Nature*, 168, 382 (1951); *Proc. Nat. Inst. Sci. India*, 20, 6 (1954).

³ Overbeek, J. Van, *Proc. U.S. Nat. Acad. Sci.*, 21, 292 (1935).

⁴ Galston, A. W., and Baker, R. S., *Amer. J. Bot.*, 36, 773 (1949).

⁵ Das, T. M., Ph.D. thesis, Univ. London (1953).

A Mosaic Disease of Leguminous Plants caused by a Strain of Tobacco Mosaic Virus

WHILE collecting viruses for use in investigating the inhibition of virus infectivity by extracts of *Theobroma cacao* L., one was found causing a systemic mosaic disease in cow-pea (*Vigna unguiculata* (L.) Walp.) and Bengal bean (*Mucuna atterima* Holland). The behaviour and properties of the virus suggest that it is related to tobacco mosaic virus, although we have been unable to find any previous report of strains of this virus infecting leguminous plants systemically.

The leaves of infected cow-pea and Bengal bean show light and dark green mottling which varies in severity, and they are somewhat distorted. The disease is now prevalent in these two crops at Moor Plantation; but there is no reason to think that it is a recent introduction. Mosaic symptoms have been recorded commonly in cow-pea and Bengal bean since 1941, not only at Moor Plantation but also at several farms of the Department of Agriculture in the Western and Northern Regions of Nigeria.

The virus is easily transmitted by inoculating sap from diseased plants to cow-pea, Bengal bean, *Nicotiana tabacum* L., *Nicotiana glutinosa* L. and several varieties of French bean (*Phaseolus vulgaris* L.). The only symptoms in *N. glutinosa* are necrotic local lesions; in *N. tabacum* var. Virginia Hybrid, chlorotic primary lesions are followed by a systemic mosaic and distortion of the leaves. The virus from cow-pea causes a systemic mosaic on the fourteen varieties of French bean tested, in contrast to our stock strain of tobacco mosaic virus, which produces discrete local lesions on some varieties but no systemic symptoms in any.

Colourless preparations of the cow-pea mosaic virus were readily made from the sap of infected tobacco plants by repeated precipitation with ammonium sulphate, and solutions of the purified virus showed the phenomenon of anisotropy of flow strongly. Mr. F. C. Bawden, of Rothamsted Experimental Station, found that a purified preparation was precipitated specifically with an antiserum prepared against his stock strain of tobacco mosaic virus, and with the electron microscope Mr. H. L. Nixon found that it contained rod-shaped particles of varying lengths, indistinguishable from the particles of strains of tobacco mosaic virus he had previously examined. In the Rothamsted glasshouses in December, the

virus produced a systemic mosaic disease in *P. vulgaris* var. Prince.

This communication is published by permission of the Director of Cocoa Research.

R. M. LISTER

J. M. THRESH

West African Cocoa Research Institute

Substation,

Moor Plantation,

Ibadan, Nigeria.

March 22.

Normal Mouth and Intestinal Flora of the Ferret (*Mustela furo* L.)

ALTHOUGH the ferret is widely used as an experimental animal, particularly in the study of virus diseases, very little work has been done on the commensal bacteria of the animal itself. Some work on its pathological conditions has been published by Hughes¹, Momberg-Jorgensen², Symmers and Thomson³, Symmers, Thomson and Iland⁴, and Skulski and Symmers⁵; but none has been found concerning the bacterial flora which can commonly be isolated from the mouth and intestine of the healthy ferret. The present investigation was made to study this flora, in a colony of tuberculosis-free ferrets, maintained in first-class conditions, which has its own unit of breeding gills, and is augmented at intervals by fresh stock purchased from breeders in the surrounding area.

One hundred and eighteen ferrets were examined as soon as possible after joining the colony. Swabs were taken from the mouth and throat and from the rectum. These were cultured on horse-blood agar and McConkey's medium, and incubated aerobically and anaerobically at 37°C. for a minimum period of 72 hr. The animals were fasted for 16 hr. before being swabbed orally.

As it was not practicable to kill healthy ferrets, the internal organs were not examined. Therefore, no results are available for comparison with those of Schweinburg and Sylvester⁶ in other laboratory animals.

The flora isolated from the ferrets was usually mixed, comprising at least two bacterial species; but these were not always the same from the mouth and the rectum. The commonest organism was *Bacterium coli*, which was isolated from 108 of the 118 ferrets (91.5 per cent). Most strains were lactose fermenters but nine were atypical varieties. The other bacteria isolated were strains of *Proteus vulgaris*, *Staphylococcus albus*, alpha- and beta-haemolytic streptococci, *Micrococcus catarrhalis*, diphtheroids chiefly *Corynebacterium xerosis* types, *Pseudomonas pyocyanea* and Gram-positive spore-bearing bacilli. These bacteria were not further identified nor was any selected for individual study.

The observations are grouped in Table 1 to show the site of origin of each bacterial species and the number of times it was isolated, and in Table 2 to show the number of ferrets from which one or more bacterial species were isolated.

From these observations it would appear that the flora of the alimentary tract of the ferret is similar to that of other animals. The relatively high proportion of strains of *Proteus* which was isolated from 74 of 118 ferrets (62.7 per cent) might be significant, although a comparable proportion was reported by Goret *et al.*⁷, who found it in the faeces of 68.1 per cent

Table 1

Bacterium	Number of ferrets from which it was isolated			
	Oral swab	Rectal swab	Both	Total
<i>Bact. coli</i> , typical	10	27	53	90
<i>Bact. coli</i> , atypical	5	3	0	8
<i>P. vulgaris</i>	12	48	14	74
<i>Staph. albus</i>	43	7	5	55
<i>Streptococcus</i>				
alpha-haemolytic	25	6	0	31
beta-haemolytic	3	7	0	10
<i>M. catarrhalis</i>	21	0	0	21
Diphtheroids	14	0	0	14
<i>Ps. pyocyanea</i>	17	1	1	19
Spore-bearing bacilli	3	3	0	6

Table 2

Number of bacterial species isolated per ferret	1	2	3	4	5	6	7	8
Number of ferrets	9	35	36	29	8	1	0	0

of dogs which showed no signs of intestinal infection. The absence of anaerobes such as the *Clostridia* commonly present in the faeces of many animals is also noteworthy.

M. ELIZABETH DAVIES

Animal Health Trust Canine Research Station,

Kennett,

Nr. Newmarket, Suffolk.

¹ Hughes, D. L., in "The UFAW Handbook on the Care and Management of Laboratory Animals", A. N. Worden, ed. (Baillière, Tindall and Cox, London, 1947).

² Momberg-Jorgensen, H. C., *Acta. Path. Microbiol., Scand.*, 29, 297 (1951).

³ Symmers, W. St. C., and Thomson, A. P. D., *J. Path. Bact.*, 65, 481 (1953).

⁴ Symmers, W. St. C., Thomson, A. P. D., and Iland, C. N., *J. Comp. Path.*, 63, 20 (1953).

⁵ Skulski, G., and Symmers, W. St. C., *J. Comp. Path.*, 64, 306 (1954).

⁶ Schweinburg, F. B., and Sylvester, E. M., *Proc. Soc. Exp. Biol., N.Y.*, 82, 527 (1953).

⁷ Goret, P., Brion, A., Joubert, L., Renault, L., Courtis, B., Jouinot, G., and Clavel, P., *Bull. Soc. Sci. Vet. Lyon.*, 53, 164 (1951).

Effect of Chloretone on Tunicate Embryos

It has been known for many years that amphibian embryos, allowed to develop under narcosis before muscular movements start, show the normal reflex and muscular activity when removed from the anaesthetic¹. Amphibian tadpoles can be narcotized only for short periods, as they need to feed.

The tadpoles of *Ciona intestinalis* do not suffer this disadvantage, as they do not feed before metamorphosis. I have found that embryos of *Ciona* placed in 0.1 per cent chloretone in sea water five hours before hatching do not show the muscular twitching seen in controls and show no hatching movements at all. In the majority of cases the egg membranes eventually disintegrate, but in some they remain intact until metamorphosis is well advanced. The narcotized tadpoles metamorphose at approximately the same time as free-swimming controls. A period of free swimming has previously been thought necessary for metamorphosis² in the non-viviparous ascidians; but the observation reported here does not support this.

L. G. E. BELL

Department of Zoology,

King's College,

London, W.C.2.

Jan. 31.

¹ Harrison, *Amer. J. Anat.*, 3, 197 (1904). Mathews and Detwiler, *J. Exp. Zool.*, 45, 279 (1926).

² Glaser and Anslow, *J. Exp. Zool.*, 111, 117 (1949). Grave, Carnegie Inst. Wash. Pub., 29, 143 (1935).

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Tuesday, June 14

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Wednesday, June 15

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 8 p.m.—Mr. John Madge: "Social Policy in Relation to Housing". (Sixth of seven University Extension Lectures of "The Development and Pattern of the Social Services".)

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the CHALLENGER SOCIETY, at 49 Cromwell Road, London, S.W.7), at 5.15 p.m.—Discussion on "Wind and Waves".*

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual General Meeting, followed by Lieut.-Gen. Sir William MacArthur: "An Account of Some of Sir David Bruce's Researches, based on his Own Manuscript Notes".

Thursday, June 16

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. C. H. Best, F.R.S.: "Dietary Factors in the Protection of the Liver, Kidneys, Heart and other Organs in Experimental Animals—the Lipotropic Agents" (Croonian Lecture).

INSTITUTION OF MINING AND METALLURGY (in the Apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. Haslam, Mr. R. D. J. Owens and Mr. J. Hancock: "Application of Plastic Igniter Cord to Blasting Operations in Metalliferous Mines"; Dr. G. A. Schnellmann: "Concealed Lead-Zinc Fields in England".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. K. W. Gruenberg: "Recent Work on the Commutator Structure of Infinite Groups".

Friday, June 17

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Discussion on "The Requirement for Radar Charts at Sea".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Sir Harold Spencer Jones, F.R.S.: "The International Geophysical Year".

Saturday, June 18

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University of Oxford), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER or LECTURER IN ZOOLOGY—The Registrar, The University, Hull (June 15).

LECTURER (Grade II) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Birmingham 15 (June 15).

LECTURER (with a degree in dairying and a strong background of bacteriology) IN DAIRYING AND HEAD OF THE DAIRY SCHOOL—The Principal, Seale-Hayne Agricultural College, Newton Abbot, Devon (June 15).

ASSISTANT, Grade B (with a good honours degree and preferably industrial or teaching experience) to teach organic or inorganic chemistry to degree level and general chemistry to intermediate level—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex (June 18).

ASSISTANT EXPERIMENTAL OFFICER IN THE DEPARTMENT OF PHYSIOLOGY AND PLANT CULTURE to assist in experiments concerned with the control of plant environment—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (June 18).

LECTURER IN PUBLIC HEALTH AND SOCIAL MEDICINE—The Secretary, The University, Aberdeen (June 18).

LECTURERS (2) (with teaching and industrial experience and a special knowledge of one of the following: electrical machinery, vibration analysis and engineering acoustics, communications (other than radio)) IN ELECTRICAL ENGINEERING—The Secretary of University Court, The University, Glasgow (June 18).

RESEARCH DEMONSTRATOR IN PURE MATHEMATICS—The Registrar, The University, Sheffield (June 18).

SCIENTIFIC OFFICER, Grade 3 (with a university degree of high standard in aeronautical engineering or equivalent qualifications, and several years experience in wind tunnel investigations related to the aerodynamic development of aircraft missiles), IN THE AERONAUTICAL RESEARCH LABORATORIES, Department of Supply, Fishermen's Bend, Victoria, Australia, to work on the aerodynamic development and research relating to new types of aircraft and missiles, and on general problems of low speed aerodynamics—The Senior Representative (A.P.28), Department of Supply, Australia House, Strand, London, W.C.2 (June 18).

SENIOR LECTURER (with a degree in pharmacy and teaching and research experience) IN PHARMACEUTICS—The Registrar, College of Technology, Suffolk Street, Birmingham (June 18).

SENIOR RESEARCH FELLOW or RESEARCH FELLOW IN THE DEPARTMENT OF PURE MATHEMATICS—The Secretary, The University, Birmingham 15 (June 18).

ASSISTANT LECTURER (Grade III) IN PHYSIOLOGY (Veterinary)—The Registrar, The University, Bristol 8 (June 20).

ASSISTANT LECTURER IN STATISTICS—The Registrar, The University, Leeds (June 20).

LECTURER or ASSISTANT LECTURER (with special interests in inorganic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 20).

TUTORIAL STUDENTS (graduates or about to graduate) IN BOTANY, MATHEMATICS, MECHANICAL ENGINEERING and PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (June 20).

LECTURER IN BACTERIOLOGY—The Secretary, The University, Aberdeen (June 23).

LECTURER or ASSISTANT LECTURER (with special qualifications in inorganic or physical chemistry) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (June 25).

SENIOR LECTURER IN PATHOLOGY—The Registrar, The University, Sheffield (June 25).

SENIOR LECTURER IN RADIOCHEMISTRY IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (June 25).

SENIOR LECTURER IN THE DEPARTMENT OF PATHOLOGY—The Secretary, The University, Edinburgh (June 25).

PROFESSOR (scholar of high repute and with extensive research work in both experimental and theoretical nuclear physics and experience in guiding research in nuclear physics) OF THE INSTITUTE FOR NUCLEAR PHYSICS—The Director, Institute for Nuclear Physics, 32 Upper Circular Road, Calcutta 9 (June 27).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Sheffield (June 28).

SHELL STUDENTS IN CHEMICAL ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (June 28).

LECTURER IN MATHEMATICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

LECTURER (with experience in the field of inter-connected power systems) IN ELECTRICAL ENGINEERING at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

MAY and BAKER RESEARCH FELLOW (graduate in science, with specialization in biochemistry and plant physiology), to undertake research work on plant growth-regulating substances, under the direction of Prof. R. L. Wain—The Registrar, Wye College (University of London), Wye, Ashford, Kent (June 30).

RESEARCH ASSISTANT IN THE DEPARTMENT OF GEOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 30).

SENIOR LECTURER IN APPLIED MATHEMATICS at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

SENIOR RESEARCH FELLOW (graduate in science or chemical engineering and experience in coal research) IN COAL RESEARCH, at the University of Sydney, Australia, to plan and undertake research on occurrence, nature, or utilization of coal—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Sydney, June 30).

SENIOR TECHNICIAN IN THE DEPARTMENT OF PHYSICS, TECHNICIAN IN THE DEPARTMENT OF CHEMISTRY, and a TECHNICIAN IN THE DEPARTMENT OF AGRICULTURE, at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

STUDENTS (honours graduates in physics or in a biological subject) IN BIOPHYSICS and in MEDICAL PHYSICS, in the Physics Department—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3 (June 30).

DEMONSTRATOR (preferably wanting research experience in cytology) IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Leeds 2 (July 1).

CHEMIST or PHYSICIST Senior Technical Officer or Technical Officer grade (with a university degree in science with chemistry or physics as a major subject, or a Technical College diploma in chemistry, physics or chemical engineering, or equivalent qualifications), IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Section of Organic Chemistry, Commonwealth Scientific and Industrial Research Organization, Fishermen's Bend, Melbourne, Australia, to assist in the development and application of distillation and other techniques to the chemical examination of fats and waxes—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (July 2).

LECTURER/SENIOR LECTURER IN BOTANY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 2).

LECTURERS (2) IN BIOPHYSICS—The Secretary, The University, Edinburgh (July 2).

SENIOR LECTURER IN STATISTICS at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 4).

LECTURER or ASSISTANT LECTURER (with medical qualifications), IN PHYSIOLOGY—The Registrar, Trinity College, Dublin (July 9).

SENIOR LECTURER or LECTURER IN PHYSICS at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Dunedin, July 15).

GEOLOGIST (with a degree or equivalent in geology or passed the final examination leading to a degree, and a satisfactory knowledge of (a) petrology and mineralogy or (b) the geology and mapping of glacial and other unconsolidated deposits or (c) stratigraphy and palaeontology) IN THE IRISH GEOLOGICAL SURVEY—The Secretary, Civil Service Commission 45 Upper O'Connell Street, Dublin (July 29).

LECTURER IN ANTHROPOLOGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London W.C.1 (New Zealand, July 31).

LECTURER IN PHILOSOPHY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 1).

ASSISTANT BIOCHEMIST (B.Sc. with a first- or second-class honours degree in chemistry or biochemistry, or the A.R.I.C.)—The Administrative Officer, Group Pathology Laboratory, Withington Hospital, Manchester 20.

ASSISTANT GOVERNMENT CHEMIST (Fellow or Associate of the R.I.C. (Branch E.) or with an honours degree in chemistry of a British university or equivalent qualifications) in Nigeria, for general analytical duties including bacteriological and chemical analysis of water, and forensic work—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.97/14/01.

BRITISH NYLON SPINNERS LIMITED RESEARCH FELLOW for work on the structure of wool and nylon staple fibre fabrics—The Principal, Technical College, Bradford 7.

ELECTRICAL ENGINEERS and PHYSICISTS (preferably with H.N.S. or degree in physics or electrical engineering, or at least H.S.C. (science) or equivalent) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work, mainly on radar and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.231/5A.

LECTURER (Grade II) in ZOOLOGY—The Registrar, The University, Edgbaston, Birmingham.

LECTURER IN INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham 15.

LECTURER (with a good honours degree in electrical engineering and experience in servo-mechanisms) in ELECTRONICS—The Secretary, Royal Technical College, Glasgow.

LECTURER (with a university degree in agriculture, and preferably with a knowledge of tropical agriculture and some teaching experience) in AGRICULTURE, at the College of Agriculture, Mauritius—The Director of Recruitment, Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.65/52/06.

PROFESSORS OF STRUCTURAL ENGINEERING; HYDRAULIC ENGINEERING; MECHANICAL ENGINEERING; and MECHANICAL ENGINEERING with special qualifications in applied thermodynamics and machine design; Electronics and Telecommunications Engineering; Mathematics; Physical Chemistry; Chemical Engineering and Applied Biology, at the Israel Institute of Technology, Haifa, Israel—The Secretary, The Technion Society of Great Britain, 83 Wimpole Street, London, W.1.

RESEARCH ASSISTANT (Ph.D. standard), for work on reaction kinetics at gas-solid interfaces—Dr. F. C. Tompkins, F.R.S., Imperial College, London, S.W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Publications of the Thoresby Society. Kirkstall Abbey Excavation—Fifth Report, 1954. Pp. 67–82 + plates 9 and 10. (Leeds: Thoresby Society, 1955.) 1s. [124]

Lundy Field Society. Eighth Annual Report, 1954. Pp. 45 + 2 plates. (Exeter: L. A. Harvey, University College, 1955. (Secretary, Lundy Field Society.) 2s. 6d. [124]

Aluminium Development Association. Information Bulletin No. 7: Machining Aluminium. Pp. 56. (London: Aluminium Development Association, 1954.) 2s. [124]

General Register Office. The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates. Quarter ended 31st December, 1954. (No. 424, 4th Qtr. 1954.) Pp. 35. (London: H.M. Stationery Office, 1955.) 2s. net. [124]

Ramblers' Association. Annual Report of the Ramblers' Association, 1954. Pp. 34. (London: Ramblers' Association, 1955.) [124]

Science Masters' Association. Report of Committee and Balance Sheets, 1954. Pp. 34. (London: Science Masters' Association, 1955.) [124]

Royal Technical College, Glasgow. Annual Report of the One Hundred and Fifty-Eighth Session, 1953–1954. Pp. 40. (Glasgow: Royal Technical College, 1954.) [124]

Rowett Research Institute. Collected Papers—Summary and Subject Reviews. Vol. 11. Pp. 44. (Bucksburn, Aberdeenshire: Rowett Research Institute, 1955.) 5s. [124]

Veterinary Reviews and Annotations. Vol. 1, Part 1 (April 1955). Prepared by the Commonwealth Bureau of Animal Health, Weybridge, Surrey, England. Pp. 54. (Published half-yearly, two issues per volume. Annual subscription, 25s.) (Farnham Royal: Commonwealth Agricultural Bureaux, 1955.) [124]

Scottish Education Department. Supply of Teachers of Mathematics and Science in Scotland: Report of the Committee appointed by the Secretary of State for Scotland. Pp. 40 (Cmd. 9419). (Edinburgh: H.M. Stationery Office, 1955.) 1s. 6d. net. [124]

Ministry of Education: Science Museum. Handbook of the Collection Illustrating Temperature Measurement and Control. By J. A. Chaldecott. Part 2: Catalogue of Exhibits with Descriptive Notes. Pp. vi + 57 + 6 plates. (London: H.M. Stationery Office, 1955.) 3s. 6d. net. [124]

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research, for the year 1954. Pp. vi + 65 + 4 plates. (London: H.M. Stationery Office, 1955.) 3s. 6d. net. [124]

Other Countries

Veröffentlichungen des Fraunhofer Instituts Freiburg I.B. Sonnen-Zirkular für die Monate Oktober, November, Dezember, 1954. Pp. 44. (Freiburg I.B.: Fraunhofer Institut, 1955.) [124]

Canada: Department of Mines and Technical Surveys. Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 9, No. 13: Spectrographic Orbital Elements for the Binary H.D. 110533. By Andrew McKellar and Hubert Reeves. Pp. 399–408. 25 cents. Vol. 9, No. 14: The Orbits of Two F-Type Spectroscopic Binary Stars. By K. O. Wright and R. E. Pugh. Pp. 407–414. 25 cents. Vol. 10, No. 3: On the Radial-Velocity Variations of α Draconis. By Anne B. Underhill. Pp. 79–86. 25 cents. (Ottawa: Queen's Printer, 1954 and 1955.) [124]

Canada: Department of Mines and Technical Surveys. Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology. No. 14: Items 8302–8546 (July to December, 1953). By W. E. T. Smith. Pp. i + 281–308. (Ottawa: Queen's Printer, 1955.) 25 cents. [125]

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Memoir 275: Geology of Harbour Grace Map Area, Newfoundland. By R. D. Hutchinson. Pp. v + 43 (5 plates). 50 cents. Memoir 277: Southeast Cape Breton Island, Nova Scotia. By L. J. Weeks. Pp. vii + 112 + 1 plate. 75 cents. (Ottawa: Queen's Printer, 1953 and 1954.) [124]

Institut pour la Recherche Scientifique en Afrique Centrale. (I.R.S.A.C.) Cinquième Rapport Annuel, 1952. Pp. 377. (Bruxelles: Institut pour la Recherche Scientifique en Afrique Centrale, 1955.) [124]

Thirty-fifth Report of the Quebec Society for the Protection of Plants, 1953. Pp. 78. (Quebec: Ministry of Agriculture, 1955.) [124]

Canada: Department of Mines and Technical Surveys. Annual Report for the fiscal year 1953–54. Pp. 107. (Ottawa: Queen's Printer, 1954.) [124]

Mitteilungen des Deutschen Wetterdienstes. Nr. 11 (Band 2): Zur Bestimmung der Verdunstung auf möglichst einfache Weise. Von Waldemar Haude. Pp. 24. 2.20 D. marks. Nr. 12 (Band 2): Frischschutz mittels Propeller. Von Josef van Elmern. Pp. 30. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) [124]

Segundo Symposium sobre Algunos problemas matemáticos que se están estudiando en Latino América, Villavicencio-Mendoza 21–25 Julio, 1954. (Symposium organizado por la Universidad Nacional de Cuyo y el Centro de Cooperación Científica de la Unesco para América Latina.) Pp. 328. (Montevideo: Centro de Cooperación Científica de la Unesco para América Latina, 1954.) [124]

Union of South Africa: Department of Commerce and Industries. Division of Fisheries. Investigational Report No. 17: The South African Pilchard (*Sardinops ocellata*). Plankton Studies In and Around St. Helena Bay, 1950–51. By B. v. D. de Jager. Pp. 26. Investigational Report No. 18: The South African Pilchard (*Sardinops ocellata*). Bird Predators, 1953–5. By D. H. Davies. Pp. 32. (Pretoria: Government Printer, 1954 and 1955.) [124]

Transactions of the American Philosophical Society. New Series—Vol. 45, Part 1 (1955): Clarence Luther Herrick: Pioneer, Naturalist, Teacher, and Psychobiologist. By Prof. Charles Judson Herrick. Pp. ii + 85. (Philadelphia: American Philosophical Society, 1955.) 1.50 dollars. [124]

Bernice P. Bishop Museum. Bulletin 214: Archaeological Fishbones Collected by E. W. Gifford in Fiji. By Henry W. Fowler. Pp. 51. (Honolulu: Bernice P. Bishop Museum, 1955.) [124]

United States Department of Agriculture. Leaflet 384: Chestnut Weevils: How to Control Them. Pp. 8. (Washington, D.C.: Government Printing Office, 1955.) 5 cents. [124]

Informal Report by the U.S. Delegation to the Eighth Session of the General Conference of the United Nations Educational, Scientific and Cultural Organization, November 12–December 10, 1954, Montevideo, Uruguay. (Department of State Publication 5777.) Pp. 14. (Washington, D.C.: Department of State, 1955.) [124]

Polish Academy of Sciences. Quarterly Review of Publications. Nr. 1. Pp. 36. (Warsaw: Polish Academy of Sciences, 1955.) [124]

World Health Organization. Official Records of the World Health Organization No. 59: The Work of WHO, 1954—Annual Report of the Director-General to the World Health Assembly and to the United Nations. Pp. x + 210 + 16 plates. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 10s.; 2 dollars; 6 Swiss francs. [124]

Science Tools: the LKB Instrument Journal. Vol. 1, No. 1 (April, 1954). Pp. 8. (Stockholm: LKB-Produkter, 1954.) [124]

L'Institut Royal Météorologique de Belgique. Pp. 215. (Uccle, Bruxelles: L'Institut Royal Météorologique de Belgique, 1954.) [124]

World University Service. Universities in Africa: Report on a Visit in March–April, 1954. By Douglas J. Altken. Pp. iv + 33. (Geneva and London: World University Service, 1954.) [124]

Editorial and Publishing Offices of "NATURE"

MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831. Telegram: Phusis Lesquare London

Annual subscription £6, payable in advance,
postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

NATURE

No. 4468

SATURDAY, JUNE 18, 1955

Vol. 175

CONTENTS

	Page
Education in the Modern World	1051
Greek Mathematics. By Dr. H. R. Calvert	1053
Natural and Artificial Snow. By G. Seligman	1054
Birds of the South-west Asian Desert. By Sir Landsborough Thomson, C.B., O.B.E.	1055
"Tektopia." By Dr. F. Sherwood Taylor	1055
A Man-carrying Centrifuge. By Wing Commander F. Latham	1057
Semiconductors: No Man's Land between Metals and Insulators. By R. W. Douglas	1059
The Museum of English Rural Life. By J. W. Y. Higgs	1061
International Conference on Marine Biological Laboratories. By Prof. C. M. Yonge, C.B.E., F.R.S., and F. S. Russell, C.B.E., F.R.S.	1062
Obituaries:	
Engineer-Captain Edgar C. Smith, O.B.E., R.N. By J. Foster Petree	1063
Prof. D. Y. Solandt. By Prof. Charles H. Best, C.B.E., F.R.S.	1063
Mr. C. H. Dinham	1064
News and Views	1064
New Physics Laboratories at University College, London	1069
The Pharmaceutical Society	1070
Condensation Nuclei: Symposium in Dublin. By Prof. L. W. Pollak	1072
Tapeworms of the Family Tetrabothriidae. By the Hon. Miriam Rothschild	1073
Radio Emission from Jupiter	1074
Abnormal Protein associated with Tobacco Mosaic Virus. By Dr. Alexander Rich, Dr. J. D. Dunitz and P. Newmark; Dr. Rosalind E. Franklin and Dr. Barry Commoner	1074
Letters to the Editors:	
Effect of Delayed Acoustic Feed-back on some Non-vocal Activities.—Dr. H. Kalmus, P. Denes and Dr. D. B. Fry	1078
Improved Resolution with the X-Ray Projection Microscope.—Dr. W. C. Nixon	1078
An Alternative Identification of the Radio Source in the Direction of the Galactic Centre.—R. D. Davies and D. R. W. Williams	1079
Effect of Density Differences on the Path of Jets.—G. Horn and Prof. M. W. Thring	1081
Fluorescence Centres in Uranium-activated Sodium Fluoride.—W. A. Runciman	1082
A Method of measuring Stress in Dentures.—E. A. Wain	1082
The Amorphous Alloy.—Dr. D. McLean	1083
Paper Electrophoresis of Reducing Agents.—H. W. Wood	1084
Estimation of Phenolic Substances: Use of Stabilized <i>p</i> -Aminodiethylaniline.—Dr. B. Camber	1085
Destruction of Isoflavonoid in the Presence of Haemin.—Prof. Robert Knox, Prof. Adrien Albert and C. W. Rees	1085
Some Unusual Carotenoids from Two Nudibranch Slugs and a Lampbrush Fish.—Dr. T. W. Goodwin and Prof. D. L. Fox	1086
Intracellular Distribution of Xanthine Oxidase in the Rat Liver.—Dr. Gilberto G. Villela, Emilio Mitidieri and Ottilia R. Affonso	1087
Actively Acquired Tolerance to a Mouse Tumour.—Dr. H. Koprowski	1087
Parasitological Significance of Bovine Grazing Behaviour.—J. F. Michel	1088
Classification of Geckos.—Garth Underwood	1089
Scale-eating Habits of African Cichlid Fishes.—G. Fryer, P. H. Greenwood and Dr. E. Trewavas	1089
Permanent Preparations of Nematodes.—E. J. Perkins	1090
Adaptability of Wheat Varieties to Acid Soils.—M. Neenan	1090
Disomic Addition of Rye Chromosome II to Wheat.—V. Chapman and Ralph Riley	1091
"The Sources of Eddington's Philosophy."—Prof. Herbert Dingle	1092

Editorial and Publishing Offices of Nature

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number : Whitehall 8831. Telegrams : Phusis Lesquare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1

Telephone Number : Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

CHAPMAN & HALL

Published 25th June

NEW METHODS IN ANALYTICAL CHEMISTRY.

by

RONALD BELCHER
B.Sc., Ph.D., F.R.I.C., F.INST.F.
(Reader in Analytical Chemistry
University of Birmingham)

and

CECIL L. WILSON
Ph.D., D.Sc., F.R.I.C., F.I.C.I.
(Reader in Analytical Chemistry
The Queen's University, Belfast)

Size: 8½ in. × 5½ in.

300 pages

Illustrated

30s. net

GEOLOGY IN ENGINEERING

by

J. R. SCHULTZ, Ph.D., and A. B. CLEAVES, Ph.D.
(Respectively, Chief, Geology Branch, Waterways Experiment Station, Vicksburg, Miss.,
and Professor of Geology, Washington University, St. Louis)

Size: 8½ in. × 5½ in.

592 pages

Illustrated

70s. net

PRINCIPLES OF EMULSION TECHNOLOGY

by

PAUL BECHER
(Senior Project Chemist, Colgate-Palmolive Co., U.S.A.)

Size: 7 in. × 4½ in.

149 pages

Illustrated

24s. net

37 ESSEX STREET, LONDON, W.C.2

PRECISION  INSTRUMENTS

Refractometers for Industry and Research

Our well-known standard Abbe type refractometer has a refractive index scale on glass and is read by transmitted light, thus leading to greater convenience in taking measurements and a higher degree of accuracy.

The instrument as illustrated is supplied with degree scale arc and micrometer screw reading directly to 10 seconds, corresponding to a refractive index accuracy within 0.00005. Conversion tables for use with sodium light are supplied.

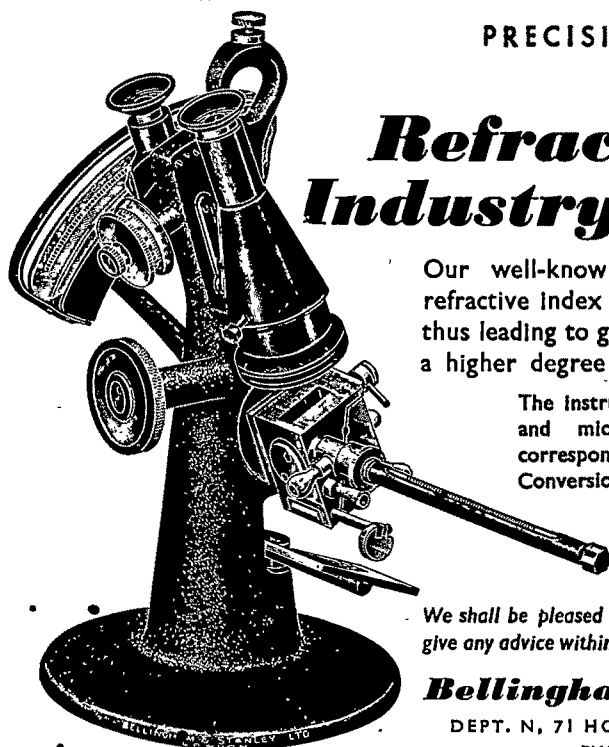
Full particulars sent on application.

We shall be pleased to demonstrate these instruments and give any advice within our power, if you will call at our Stand

Bellingham & Stanley Ltd.

DEPT. N, 71 HORNSEY RISE, LONDON, N.19

PHONE: ARCHWAY 2270



EDUCATION IN THE MODERN WORLD

VARIOUS reports which during the past two years have dealt with the shortage of science teachers, the expansion of technological education, and the loss of promising students through early school-leaving have increasingly emphasized the dependence of the effectiveness of educational policy in general or of particular measures on public understanding and support. Three years ago, the Advisory Council on Scientific Policy commented on an obstacle deflecting many of the ablest boys from a scientific career—that of the attitude of their parents. The recent report on early school-leaving supplied emphatic evidence of the extent to which the influence of the home could be adverse, and of the frustration and waste that could result if educational policy and institutions were not in harmony with the outlook and aspirations of the home.

References of a similar character are to be found in the report from the Federation of British Industries' Committee on the "Shortage of Science Teachers", in that on "Graduate Teachers of Mathematics and Science" from the National Advisory Council on the Training and Supply of Teachers and, still more recently, from the Committee on the Supply of Teachers of Mathematics and Science in Scotland, appointed in October 1953, with Sir Edward Appleton as chairman*. None of these reports raises the direct question whether the educational system of Britain really fits the society in which we live; but the Appleton report in particular, although by its terms of reference concerned solely with the causes and effects of present and prospective shortages of teachers of mathematics and science in Scottish secondary schools and possible remedies, sees the whole problem against the wider background, and its diagnosis and recommendations have a validity far beyond the Committee's field. The report itself emphasizes the extent to which some of its recommendations will have repercussions outside the sphere with which the Committee was directly concerned.

Some of these repercussions impinge on those coming from the increased awards for university students recently announced by the Minister of Education and from those of the working party on "Grants to Training College Students". It will be noted that both the Minister, in commending the new arrangements to local education authorities, and the working party, in urging the adoption of broadly similar practices by training colleges and standard rates of grant by all local education authorities, appeal for co-operation from local authorities. Without such co-operation, and the public understanding and support upon which it must be based, it will be impossible to eliminate the existing wide variations in grants, and the anomalies and resentment which they engender.

More might perhaps have been said in some of these reports of the importance of seeing that the local authorities, for example, and the public which elects them, clearly understand the reasons for the proposed policy, that its purposes are clearly explained and that the real reasons for public expenditure are understood. The report on early school-leaving, indeed, faced this issue frankly in its opening paragraph; but in general more remains to be done to establish clearly in the public mind the real purposes of education, whether it be at the secondary level or at that of the training college, the technological college or the university. With State expenditure on education running at its present level, it is imperative that the public should be assisted to understand clearly exactly what we are trying to do in each type of institution, and equally what we are not trying to do.

As a contribution to public understanding, the Appleton report is outstanding. The critical importance of a single problem is clearly displayed, and its bearing on the national welfare is indicated as well as the implications and repercussions of measures designed to deal with the shortage. No reader of this report is left in doubt as to the folly of attempting to handle educational problems piecemeal or by partisan measures, though there is little that is new in the report itself. It is, above all, in presentation that the report excels.

It begins by emphasizing the gravity of the present shortage of suitably qualified teachers, pointing out that the development of scientific and technological skill upon which the economic prosperity of the nation in peace and its survival in war alike depend cannot be achieved if there is weakness at any level in the educational structure. Although the final stages of the education of those entering the scientific and technological professions are conducted by the universities and colleges of technology, these institutions look to the schools for a student entry which is adequate in both quality and quantity. Any inadequacy in the teaching of mathematics or science at school is therefore a national problem, and if it remains unsolved it endangers our economy and even our safety.

Distinguishing four categories of teachers of mathematics, the report assesses first the nature and magnitude of the problem, and here it supplies fresh information specifically for Scottish schools. Of the first of the four categories—specialist teachers with a first- or second-class honours degree or its equivalent and a specialist course of teacher training normally of one year—there was in October 1954 an actual shortage of 294, and it is estimated that the shortage in 1957 will be about 500. After that year, however, such teachers will be lost by death or retirement at the rate of fifty a year, while on present trends only thirty a year will be recruited. At the same time, the number of pupils in secondary schools will be increasing, as a result of the high post-war birth-rates, from an

* Scottish Education Department. Supply of Teachers of Mathematics and Science in Scotland: Report of the Committee appointed by the Secretary of State for Scotland. Pp. 40. (Cmd. 9419.) (Edinburgh: H.M. Stationery Office, 1955.) 1s. 6d. net.

estimated 232,000 in 1957 to a peak of about 271,000 in 1961; and it seems likely that while at present the schools require for full efficiency 18 per cent more specialist teachers of mathematics and science, by 1961 they will require at least 40 per cent more. By then the deficiency of specialist teachers will probably be about six hundred.

Shortages of specialist teachers are at present being made good numerically from the second category of teachers of mathematics and science distinguished by the Appleton Committee—sub-specialist teachers with an ordinary (or pass) or with a third-class honours degree. Of nearly 3,000 such graduates employed in Scottish schools at present, almost 2,200 are in secondary schools, and of the remainder it is estimated that not more than 200 would be available for transfer to secondary school work. If these sub-specialists are used to fill the vacant specialist posts, even by calling on the 200 in primary schools and available for transfer, the number of sub-specialist teachers of mathematics and science in the junior secondary schools is likely to fall by at least a hundred during a period when the number of pupils in these schools will rise by 30,000.

This overall shortage of some 700 specialist and sub-specialist teachers by 1961 compares with an accumulated deficiency for grant-aided schools and establishments in England and Wales estimated at 3,450 by 1960 by the National Advisory Council or 2,300 by the Federation of British Industries Committee. The Appleton Committee recognizes that graduate teachers who include mathematics or a science subject in their degree course constitute a small reserve of non-specialist teachers which could be used if the shortage became more acute; but it sees limits to the use which could be made in practice of such teachers. As regards the Committee's fourth category—general teachers for modified courses—it has in mind teachers who undertake with their pupils all the instruction necessary in such cognate groups of subjects as English, history and geography, or arithmetic and elementary science.

Obviously at this point we touch on the extent to which modification of the curriculum could alleviate the shortage. The Appleton Committee firmly rejects the idea of restricting science teaching in schools as a means of saving teaching power; but on a long-term view the way in which science is taught, either in school or university, must powerfully affect the supply and the quality of science graduates and thereby of teachers. Of the quality of science teachers the report says little. The decline in academic standards of those entering the profession is accepted, and the Committee is also fully aware of the danger of deterioration of standards when specialists are replaced by sub-specialists, and the latter by non-specialists. Able pupils, inadequately trained at school in the more advanced work in mathematics and science, may find themselves unprepared for the study of these subjects at the university-level. Other pupils, through faulty introduction, may fail to realize their aptitude for such subjects and turn elsewhere; while apart from this, adverse effects are felt over the whole school curriculum when teachers

are withdrawn from work in their own subjects to teach some mathematics or science.

The shortage of teachers of mathematics and science, however, is only one manifestation, although by far the most serious, of the shortage of teachers generally, and of the still more widespread shortage of educated man-power. A fundamental cause of this general shortage of teachers is to be found in changes in the birth-rate; present difficulties in the schools, not only in Scotland but equally in England and Wales, are aggravated by the fact that the schools are dealing with the increasing school population arising from the high post-war birth-rates at the very time when teachers are being recruited from the age-groups born in the 'thirties, when birth-rates were at their minimum. This should indeed be a salutary reminder of the importance of foresight and flexibility in planning educational policy. No adequate policy can be framed and executed if it is subject to party political pressure, and the interests of the nation and the children are made subservient to political doctrine.

The Appleton Committee analyses very clearly other contributory factors which lead it to conclude that the shortage of teachers is but one aspect of an overall shortage of educated man-power. So far as Scotland is concerned, it points out that mathematics and science have not shared in the overall numerical improvement in the staffing of schools between 1939 and 1954, and the present staffing shortage in these subjects will be aggravated when the secondary-school population begins to increase from 1958 onwards. It directs special attention to one particular feature of the shortage of educated man-power which is commonly overlooked. Over the years, the standard of general education required of those entering training for many professions has been raised, while professional courses have been lengthened and final examinations have become more exacting. While this is understandable, it has reduced the proportion of the population upon which the professions can draw.

Rising standards, in fact, conflict directly with the need for more recruits, and the Appleton Committee suggests that we may have reached a condition of unbalance which necessitates reconsideration of requirements for entrance to the universities, the higher technical institutions and the professions. That is highly relevant to the supply of teachers of mathematics and science, because that supply is affected by the demands of industry and commerce to a much greater extent than is the supply of other teachers. The Committee notes, for example, that while the annual output of such specialists from the training colleges averaged 111 during the period 1923–25, 90 in the period 1931–33 and 51 in the period 1936–38, it is now about 40. It does not consider; however, that economic factors are the sole reasons for the preference of young scientists or mathematicians for a career in research in industry or government service rather than in teaching. The passage in which the report discusses the considerations which determine the choice made by young people is one of the most important in the report.

If the bias against teaching is to be corrected, much more positive action will be required than the economic adjustments suggested by the Federation of British Industries Committee's report and others. Those who, like the Appleton Committee, have glimpsed the solid satisfactions which science teaching itself can bring must somehow convince the young scientist and mathematician that the glamour and interest are not all on one side, the drabness and drudgery all on the other. The idea that the teacher deals with this subject on a more or less static level must be dispelled, and the fascination and challenge he meets in problems of presentation and character-building, above all the opportunity and reward of being able to train young minds in the subject nearest to the heart of the teacher, must be displayed in some measure before the budding scientist or mathematician finally decides on his career. Vision indeed is demanded, but besides imagination we touch here on the matter of according the expositor his due honour. Failure to recognize the worth of the expositor may hinder not merely the use and understanding of science but also the very continuance of scientific activity.

This is essentially a matter of long-term policy; but other measures which the Appleton Committee suggest could well be used to improve the position. It does not believe that the problem of obtaining sufficient recruits for the professions will be fully solved by endeavouring to encourage more pupils to stay longer at school. It suggests rather that the professions need to reconsider their standards. Each profession should attract entrants of the highest ability, but many professions could enlarge their lower ranks with persons of less ability than those whom they seek to recruit at present.

Any such policy makes big demands on the professions for searching inquiry and constructive criticism if standards are to be maintained while the public interest is fully served. Moreover, the Appleton Committee considers it essential that an increasing proportion of the population shall be trained as scientists or technologists, and, like the Advisory Council on Scientific Policy and the Federation of British Industries, it suggests that the opportunities in science should be made more widely known both in the schools and to university students who seem to have equal aptitude for a branch of science and for some other study, and find difficulty in deciding in which to specialize. Similarly, it suggests publicity should be given, not only to the advantages of professional careers in general, but also to the very real attractions of a teacher's life.

So much for the general considerations put forward in the report of the Appleton Committee. They make its report of high importance, even apart from the detailed recommendations, some of which may be regarded as short-term measures for the amelioration of the present grave shortage of teachers of mathematics and science. The report as a whole is an outstanding contribution to the present discussion of the form and purpose of education in the world of to-day.

GREEK MATHEMATICS

Science Awakening

By B. L. Van der Waerden. (English translation by Arnold Dresden.) Pp. ii+306+28 plates. (Groningen: P. Noordhoff, Ltd., 1954.) 19 florins; 5 dollars.

SCIENCE has had many meanings; but to the modern layman it means primarily "what goes on in laboratories", and this must be taken as the generally accepted meaning of the word in the absence of any context. Science in this sense began at the Renaissance in the fifteenth and sixteenth centuries. Before this time philosophers had speculated about astronomy, optics, applied mathematics and chemistry; but they had done little more than speculate and had not thought of testing their speculations by controlled experiments. Mathematics is not usually included within the scope of the word science, so that it is necessary to refer, for example, to "a course of study in science and mathematics". The title of the book under review may thus be said to be misleading, for, instead of describing the origins of the modern scientific era, it gives an account of Greek mathematics and its origins.

The book starts with relatively short accounts of Egyptian and Babylonian mathematics and a very useful chapter on early number systems and the origins of the Hindu-Arabic numerals, discussing the invention of the positional system and the introduction of the zero. It is a surprising thought that in Europe the present number system displaced the Roman numerals only about five hundred years ago.

Although the Greeks themselves believed that mathematics originated in Egypt, recent studies by Otto Neugebauer of the cuneiform texts on clay tablets show that the Greek methods are reminiscent of the earlier Babylonian ones, and it was in fact Babylonian mathematics which supplied a basis for the remarkable Greek efflorescence. Prof. B. L. Van der Waerden gives a most illuminating picture of this early mathematics. Photographs of the papyri and cuneiform tablets are reproduced with transcriptions of the texts, so that an idea is given of the original material with which the investigator has to work. He gives copious translated extracts from such texts as the Rhind papyrus, with occasionally a literal translation followed by the modern interpretation. The account of Greek mathematics from 600 B.C. to about A.D. 500 occupies nearly three-quarters of the book and is divided into five chapters. Each of the first four chapters covers approximately a century, and the last describes the decay of Greek mathematics from the time of Apollonius, about 200 B.C.

Prof. Van der Waerden, with his experience of a life-time spent in algebraic studies, is able to penetrate the mode of thought of the pioneer mathematicians and to convey something of it to the reader. He uses his insight to deduce the origin and authorship of some of the books of Euclid's elements. The problems of the duplication of the cube and the squaring of the circle exercised the thoughts of many of the Greek mathematicians whose works are analysed. Some of the author's deductions are based on slender evidence, which is surprising, since he has a word to say on this fault in the preface. For example, he inquires how Eupalinus in 530 B.C. could construct a straight aqueduct a kilometre long through a mountain, digging from both ends at once, and says he must have used the 'Cloptra', an instrument described

nearly six centuries later by Heron of Alexandria in A.D. 60.

The book has many commendable features. There are chronological summaries in tabular form of Egyptian, Babylonian and Greek mathematics against the background of general history. There are twenty-eight excellent photographic plates which have been carefully chosen to stimulate interest and to reinforce the arguments of the text; an archaeologist, H. G. Beyen, has written useful descriptive notes about them. There is a very good index, and in the preface there is a statement of what is new in the book, so that anybody who wishes to pass over the general outlines of the subject can quickly find the new contributions to knowledge. For those with a knowledge of school mathematics and an interest in mathematical puzzles and problems, it will be a fascinating experience, and not too difficult, to follow the expert guidance of the author through the pre-Christian mathematical works and gain an insight into the mental processes of these early mathematicians. Even the too-frequent misprints and several jarring colloquialisms do not destroy the pleasure to be derived from this well-presented book.

H. R. CALVERT

NATURAL AND ARTIFICIAL SNOW

Snow Crystals

Natural and Artificial. By Ukichiro Nakaya. Pp. xii + 510. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1954.) 80s. net.

FALLING snow has fascinated observers since early days. Olaus Magnus is believed to have made the first sketches of snow crystals about A.D. 1550. More faithful drawings showing the hexagonal symmetry were made in the seventeenth century; but it was not until the later eighteenth hundreds that scientific study of the formation and development of the subject began, culminating in the important work of Hellmann in 1893. In more recent years many contributions to the subject were made, notable among which were those of Bentley and Humphries in 1931. They photographed many thousands of snow crystals and published photomicrographs of more than two thousand of these. Their method, however, was by no means perfect, and it was not until a few years later when Prof. Ukichiro Nakaya devised means of ensuring practically perfect reproduction that the picture of the snow crystal became a true one.

In 1930 Prof. Nakaya joined the Faculty of Science of Hokkaido University, Sapporo, Japan, as professor of experimental physics. Severe winters on the high ground in the centre of this northerly island stimulated his interest in snow, and two years later he began his investigations on its structure and formation. Very soon he must have devised an efficient method of photomicrography, because the results of his early observations, which he sent to me in 1934, were already far ahead of those of earlier workers, both in technical detail and in artistic merit. Later he improved his lighting technique by using "a little oblique illumination". In this way he succeeded in obtaining "a clear picture of the minute ruggedness of the surface as well as the boundary shape and

distinct images of the internal structure of the crystals".

The present book is to a large extent a recapitulation of the many papers produced by Prof. Nakaya and his associates since the thirties, but only going as far as 1946. A concluding chapter deals in summary with some later investigations. The first part deals with 'natural' snow—the many types that were observed, their physical properties, symmetry, mass, rate of fall and electrical charges. Considerable space is devoted to a general classification of snow crystals. There are seven main divisions which are sub-divided into some thirty-two specific types. These are illustrated very clearly by a series of drawings. One is immediately prompted to compare this classification with that of fallen snow recently published on behalf of the Commission on Snow and Ice of the International Association of Hydrology, in the compilation of which Prof. Nakaya helped and which appears as an appendix to his book. This was devised for the layman and, although it is much simpler, the two classifications are in reasonable accord. It would have been a useful addition to the main classification if each of the photomicrographs at the end of the book had its place in the system appended to it.

The second part of the book describes the artificial production of sublimation crystals, both of snow and 'frost' crystals (which in Britain are more usually called 'hoar' crystals). The difference between the two types is that the frost crystals develop on solid objects on, or in contact with, the ground, whereas a snow crystal grows on to a 'nucleus' consisting of "an ion or a dust or aerosol particle" in the free atmosphere. While, therefore, the production of artificial frost crystals (by allowing water vapour to rise on to a cooled surface) presented no great difficulty, the problem of how to make snow crystals was a much more complex one. Ultimately, after much experimentation, it was found that the suspension of a fine rabbit's hair in the cooled section of a simple but very ingenious apparatus provided conditions more nearly approximating to those which cause the sublimation of a minute deposit of ice on to a particle floating in the atmosphere. This early stage of the crystal the author designates as the 'germ'.

By varying the temperatures and the degree of supersaturation, Prof. Nakaya found that he could reproduce at will "almost every sort of snow crystal in the laboratory". By comparing natural snow crystals with those formed artificially under known conditions, he has attempted "to infer to some extent" the structure of the upper atmosphere, tracing the changing conditions in the various layers through which the crystal fell by identifying the various stages of its growth as shown by the photomicrographs. It will be interesting to see whether this can develop in such a way as to be of value for large-scale investigations of the upper air.

A final chapter deals very briefly with work done on falling snow by Prof. Nakaya and a few other investigators since 1946; it includes a section tentatively handling the mechanism of snow crystal formation.

Summarizing, one may call this work a descriptive treatise on the nature of snow as complete and detailed as is possible to-day. It is essentially empirical—there is little or no theory. The work of the crystallographer scarcely enters into it. A criticism that remains to be made is that some of

the terminology is a little confusing. Two examples may be quoted. It has always been accepted that amorphous deposits of ice due to the freezing of water droplets are called rime, whereas crystalline sublimation forms are known as frost (or hoar); yet the author speaks of both crystalline and amorphous forms of both rime and frost. Again, the term 'powder snow' in this book seems to denote something different from the previously accepted meaning of the word as used by snow-craftsmen all over the world. These are insignificant criticisms compared with the general excellence of this work. The portrayals of snow crystals, upwards of 1,550 in number, are of really exquisite beauty and delicacy, and the book has been handsomely produced with assistance from both American and Japanese sources. In giving praise to the author one should not forget his many helpers, whose enthusiasm, one takes leave to suggest, Prof. Nakaya has himself stimulated.

G. SELIGMAN

BIRDS OF THE SOUTH-WEST ASIAN DESERT

Birds of Arabia

By Colonel R. Meinertzhagen. Pp. xiii + 624 + 28 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 84s. net.

TWO handsome volumes on the birds of Egypt from the same authoritative pen have long stood on the ornithologist's shelves. Now Colonel R. Meinertzhagen has flanked them with the present work on the area immediately to the east; he does not restrict himself to the political boundaries of Arabia, but deals with the whole desert area of south-west Asia. Based as it is on first-hand knowledge of a subject on which there has hitherto been only a scanty and scattered literature, the book will be a standard for many years to come.

The bulk of the book consists of the systematic account of the relevant species and geographical races, for each of which particulars are given. There are also family keys to identification, and sometimes a general discussion of a genus. Many of the forms are illustrated, in colour plates or text figures, and there are maps showing the entire distribution of various species and their component races.

Short notes (listed at p. 72) on a number of general topics are interpolated in the systematic account, and there are four introductory chapters dealing respectively with the physical characteristics of the area, with desert coloration, with distribution and migration, and with systematics and nomenclature. In these general discussions the author is usually provocative, often controversial, but always stimulating. Occasionally he digresses rather far from his main theme to voice some personal opinion.

On the vexed question of desert coloration, Colonel Meinertzhagen agrees that there is much that is not yet known or fully understood. He inclines strongly to the view that the characteristic colour of desert animals has been evolved as a protection against climate rather than against predators; and that, although pattern may often be of cryptic value, shades of colour are the result of environmental influences.

The author's view is that the bulk of the migration which must traverse the area, from western Asia to

East Africa, does so by way of the land-bridge at Sinai rather than on a broad front across the main desert. In the almost complete absence of local data, he bases this opinion on his experience of migration elsewhere; but the more direct approach to the question remains as an interesting task for future observers.

There are nine photographic plates illustrating the country, and these enhance the expression of the author's love of the desert which pervades the book. The nineteen colour plates of birds, one by Thorburn, five by Lodge and thirteen by D. M. Henry, are excellent. The printing and general production are of a high order.

LANDSBOROUGH THOMSON

"TEKTOPIA"

Man and Energy

By Prof. A. R. Ubbelohde. Pp. 247 + 13 plates. (London: Hutchinson's Scientific and Technical Publications, 1954.) 18s. net.

PROF. A. R. UBBELOHDE writes with the easy confidence of a master of his subject and has given us an agreeable and unusual book, ranging around the subject of man's relation with energy. While there is nothing that will be new to those schooled in thermodynamics, his treatment will attract the layman and give him an introduction to the sciences of energy. The book is in two parts, the first dealing with the growth of the use of power by mankind, and the second with the growth of knowledge on the subject. The first and historical part breaks away from the old story that has been told so often. Prof. Ubbelohde has absorbed and quoted a number of classical authors but rarely cited, and continually presents a new angle on the story of power.

He introduces a conception new to me, one that is presumably his own, namely, that of the Tektopia. "Tektopias are theoretical constructions of ideal states, based on a large proportion of inanimate energy slaves." There would seem to be some doubt as to the merits of the Greek construction Tektopia: presumably it is a portmanteau word compressed from 'technological Utopia', but I think a Greek would suppose it to be a new disease, 'the condition of melting eyes' (i.e., eutectic and myopia). Be this as it may, the word gives the opportunity for a discussion of that way of life, unhampered by the embarrassment of having to talk about the habits of particular countries.

The second half of the book is concerned with the foundation and growth of thermodynamics. This is never an easy subject to set before the public at large, but the author has done it as well as it can be done. The cosmic consequences of the laws of thermodynamics are considered—especially with regard to the heat-death of the universe. There is also a chapter on the thermodynamics of living creatures suggesting what seemed to me to be slightly fantastic possibilities of escape of living organisms from thermodynamic laws. The book is illustrated by some good plates and some amusing little diagrams. It is admirably free from misprints, though one of them, "the technological future of mankind", was a stroke of genius by the compositor. This is a book to be recommended to all who seek the wide and human view of science.

F. SHERWOOD TAYLOR

Stainless Iron and Steel

By J. H. G. Monypenny. Vol. 2: Microstructure and Constitution. Third edition, revised. Edited by Prof. F. C. Thompson. Pp. xii+330. (London: Chapman and Hall, Ltd., 1954.) 55s. net.

PUBLICATION of the present volume completes the issue of the third edition of this well-known work, and it is a marked reflexion on economic conditions that Vol. 1, issued in 1951, has approximately two hundred pages more than the present volume, which yet costs 10s. more. Earlier editions were contained in one volume; but the considerable developments which have since occurred in the subject-matter have made two volumes necessary. Whereas the first deals with industrial and technological aspects, the present one is concerned with more fundamental considerations, namely, with the metallography of stainless and heat-resisting steels.

This work will need no recommendation to those already familiar with earlier editions. However, to others it must be emphasized that here is a well-written and careful account, expressed as simply as possible, which no one concerned with the metallurgy of stainless iron and steel can afford to ignore. Nevertheless, it is necessary to point out that the literature references are not as recent as they might be, presumably due to the unfortunate death of the author before the book was in its final form. Thus there are only four references to work published after 1943, the latest being dated 1949. A. R. BAILEY

L'heure H, a-t-elle sonné pour le Monde ?

Effets accumulatifs des explosions nucléaires. Par Charles-Noël Martin. Pp. 255+8 plates. (Paris: Bernard Grasset, 1955.) 540 francs.

THE author, M. C.-N. Martin, is concerned with the global effects of nuclear weapon tests. The main theory dominating the book is that scientists are playing with the unknown and may be exacting a heavy toll from future generations by destroying the delicate balance of Nature. The first half of the book is historical and deals with the development of nuclear technology up to the construction and testing of thermonuclear weapons. The data on the nominal atomic bomb are taken directly from the official United States publication, "The Effects of Atomic Weapons".

The second half of the book discusses the future. M. Martin defines his own position as that of the theoretician who, as distinct from, say, the specialist nuclear physicist, must survey the whole field of physics and consider all the aspects of continued weapon tests which might affect the future of mankind. He admits that it is virtually impossible for a physicist of this generation to do so efficiently, since his knowledge is not adequate; but it is "surely better to make rough estimates and to learn later that they were over-estimates rather than the reverse". This gives him his justification to proceed; but the main weakness of the following chapters is that no estimate in the real sense of the word is made at all. The reader is left to draw his own conclusions from a list of numbers and vague possibilities, with the vital links always missing. Yet much information has been published both in the United States and elsewhere from which realistic estimates could have been made of some of the effects which M. Martin describes in general terms only. Such estimates would have enabled him to consider the potential

hazards in their true perspective and to separate the real problems from the imaginary. This procedure might well have been followed for the problem raised by the global deposition of fission products: plutonium, nitric acid and carbon-14 and by the screening of solar radiation by explosion dust, to name a few.

His general arguments are not always consistent. For example, he uses incompatible models of atmospheric diffusion to support his contentions on the hazards associated with dust and with nitric acid. There are several errors of fact in the book, and some of his suggestions are far-fetched, as on p. 169 in which he suggests that nuclear weapon tests may be responsible for the appearance of flying saucers.

N. G. STEWART

Heterocyclic Compounds with Indole and Carbazole Systems

By Ward C. Cumber and F. M. Miller. (The Chemistry of Heterocyclic Compounds—Vol. 8.) Pp. xii+307. (New York: Interscience Publishers, Inc. London: Interscience Publishers, Ltd., 1954.) 1 dollars.

THIS is the eighth volume to be published in the Weissberger series of monographs on heterocyclic compounds. It presents a clear and fairly concise account of fundamental indole chemistry, embracing indole, indoline and carbazole derivatives, with separate chapters on oxygenated indoles such as oxindole, isatin and indigo. Apart from the systematic survey, the most notable feature—an one not characteristic of the series—is the inclusion of alkaloids as a topic. This occupies almost a third of the book, all the major types of indole alkaloid being represented and briefly discussed from the structural point of view. The authors aim at comprehensive rather than exhaustive treatment with literature coverage including the year 1952.

The reader who is familiar with earlier volumes in the series may miss the documented lists of individual compounds, which there supplemented the more general descriptions: on occasion, he may even be a little disconcerted when his search for detail leads from a rather slender index to a single line of text and thence to a massed array of references set at the foot of the appropriate page. Yet the book will be valued as much for its content as its clarity; and in particular, the section on indole alkaloids, although lagging already behind recent developments, may be commended to all who seek an introduction to this complicated subject.

Badgers' Year

By F. Howard Lancum. Pp. vii+71. (London: Crosby Lockwood and Sons, Ltd., 1954.) 6s. 6d. net.

THE year's cycle of behaviour in a family of badgers is the theme of Mr. Howard Lancum's new book. It relates his observations at a sett in Devonshire wood from April 1952 until March 1953 during which time he spent many nights or parts of nights (forty-six to be precise) watching the inhabitants. He stresses and re-stresses what has long been the contention of field naturalists, that the average normal badger is harmless to man, very occasional cases of poultry-slaying being the work of eccentric individuals that can rightly be termed 'rogues'. The book is illustrated with excellent photographs taken by the author, including many flashlight pictures of the badgers, both old and young. FRANCES PRITT

A MAN-CARRYING CENTRIFUGE

By WING COMMANDER F. LATHAM

R.A.F. Institute of Aviation Medicine, Farnborough

DURING the Second World War, the investigation of the physiological effects of centrifugal force encountered during combat manoeuvres in high-speed aircraft assumed increasing importance, as the tolerance of the human body to these stresses was more easily exceeded with each generation of fighter aircraft. The scope of the investigation carried out in service aircraft was necessarily limited, and for this reason human centrifuges were constructed in Canada, the United States, and also Germany, during the later stages of the War. On the basis of the knowledge gained in the design and operation of such installations, the main features of the design of a British centrifuge were decided in 1947. The man-carrying centrifuge at the R.A.F. Institute of Aviation Medicine, Farnborough, now forms the latest addition to the Institute's research equipment. Its mechanical performance and associated electro-medical equipment offer great scope for the conduct of much new basic physiological research, and for the development of equipment designed to increase the speed, comfort and efficiency of aircrew.

The centrifuge consists of a horizontal arm 62 ft. 6 in. long mounted on a 12-ton fly-wheel, which can be rotated in a precisely controlled

cycle of acceleration and deceleration. The cars carrying the human subjects are mounted on fore-and-aft trunnions at the ends of the arm, so that they can swing out on rotation and maintain the direction of the resultant centrifugal force on a subject (Fig. 1). A vertical d.c. electric motor developing 2,800 h.p. drives the arm and can be controlled either manually or automatically. The normal operating team consists of a controller, observer at the centre of the arm, recorder and subject. All these operators are linked by 'tele-talk' equipment. With automatic control, each run is governed by one of a series of interchangeable cams, each of which has been designed to give a different rate of application of acceleration from rest, with a different maximum g at the peak.

One of the outstanding features of this centrifuge is its ability to speed up and develop the accelerations on the subject extremely rapidly. With maximum performance, it will reach a speed of 54.4 r.p.m. in 9 sec., which results in a peripheral car-speed of 115 m.p.h. (equivalent to a centrifugal force of 30 g). Once the starting load has been overcome, it means that the centrifugal force can be built up at a rate of 8 g /sec., and reduced at a similar rate by regenerative

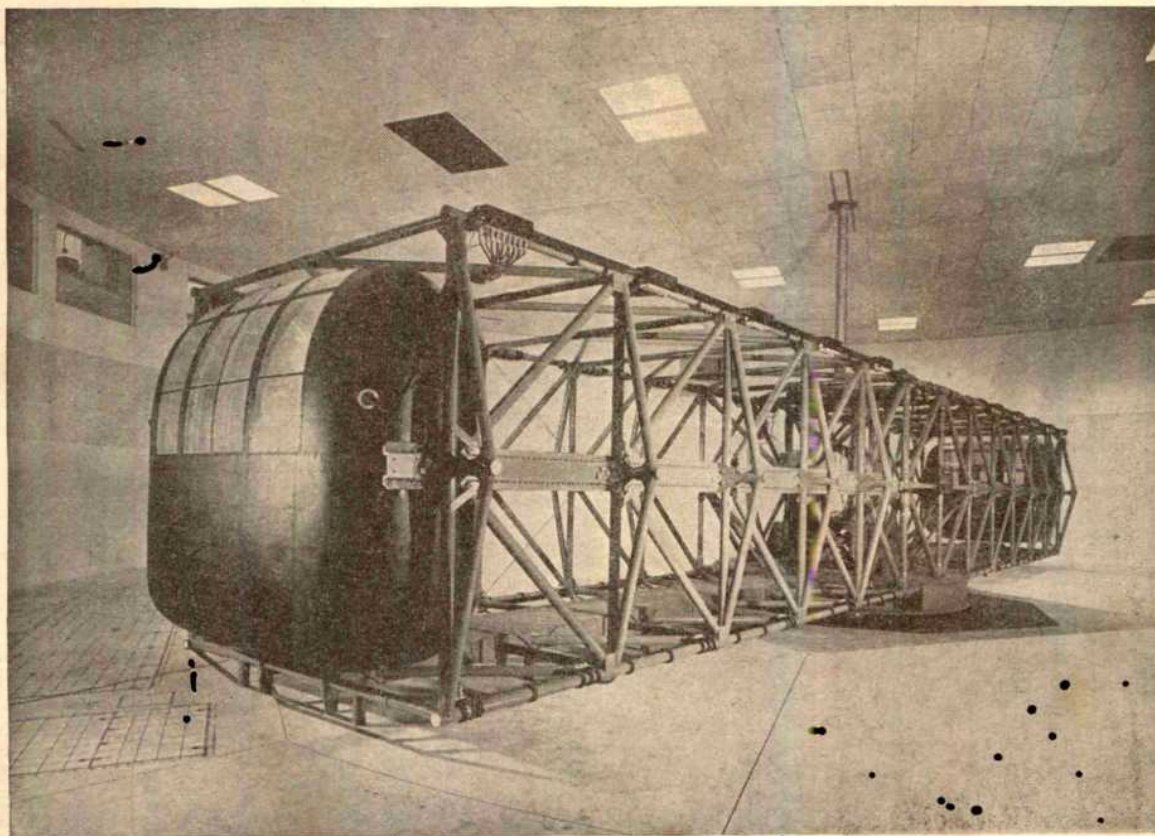


Fig. 1. Man-carrying centrifuge at the R.A.F. Institute of Aviation Medicine, Farnborough. By courtesy of the General Electric Co. Ltd.

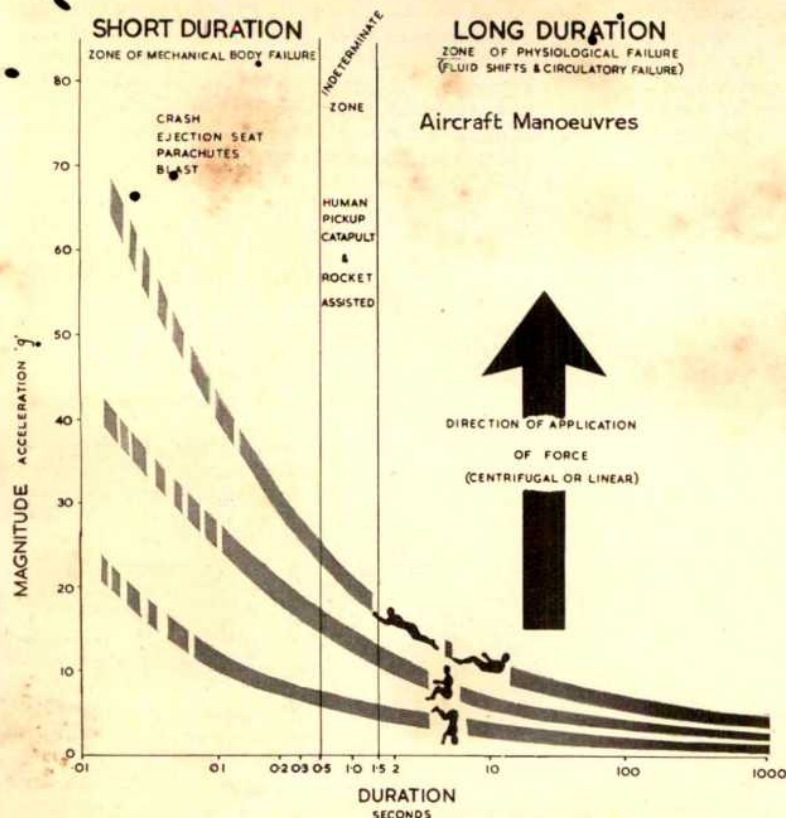


Fig. 2. Anatomical and physiological limits for acceleration in relation to duration and axes of the body

braking at the end of the run. Such a performance compares closely with the rate at which a fighter aircraft can develop g forces in combat manoeuvres. This feature is important, since time and peak acceleration are the two most critical variables which govern the physiological tolerances of the human body to acceleration stresses. Fig. 2 illustrates this problem and also shows the so-called long-duration group of accelerations which can be investigated with this equipment. Although the centrifuge was constructed primarily for medical research, its size and payload at the end of the arm of 1,150 lb. at $30g$ make it suitable for testing of aircraft and guided missile equipment. For the purpose of studying body movements under g , the cars can also be replaced by 'Sorbo'-padded compartments. The limitations of body movement can then be observed while subjects perform simple tasks such as simulating an attempt to leave an aircraft escape hatch under the influence of the increased acceleration experienced during an aircraft spin. The effects of a force of $5g$ on the soft tissues on the face of a subject are shown in Fig. 3.

One of the major problems involved in the design and construction of the building and

associated electrical equipment was that of suppression of electrical noise. It is necessary for the electro-medical leads attached to the subject in the car to be conducted along the centrifuge arm and up through the hollow central shaft to the slip-ring room on the top floor of the building, and thence to the recording room. The distance traversed by these cables before reaching the physiological amplifiers is approximately 100 ft., and the sliding contacts which intervene consist of a vertical bank of sixty silver-silver graphite slip-rings, and thirty mercury troughs. Nevertheless, it is possible with the extensive screening and suppression employed to record electroencephalographs from the subjects in the cars while the arm is rotating, with no more than $1\frac{1}{2}$ micro-volts of electrical noise on the amplifiers in the recording room. This recording equipment includes a 12-channel direct ink-writing electroencephalograph and an 18-channel galvanometer and bromide-paper recorder. In addition, there is an 18-channel d.c. amplifier. Thus all types of electro-medical transducers can be used, including strain-gauges and capacitance and inductance manometers for fluid- or air-pressure measurements. These recording facilities

have not been confined to the centrifuge building itself, and special screened-cable extensions have been relayed to the surrounding laboratories. Although it has been suggested that a centralized recording system may on occasions prove inconvenient, it has been found that the overall gain in the quality of the recording techniques and the saving of duplication of equipment have justified this system. It is considered



Fig. 3. Left: normal subject. Right: subject at $5g$

hat the screening of the building is the most effective of any centrifuge in the world.

The study of the dynamics of the blood circulation under the stress of accelerations of long duration by the use of the centrifuge should add considerably to basic knowledge in the field of cardio-vascular physiology. It is known that the phenomenon of 'black-out' in aviators during combat manoeuvres is directly related to the impairment of the blood circulation to the brain, and an adequate approach to such problems can only be made by the use of such specialized equipment where subjects can be investigated under controlled laboratory conditions. The scope of this work will be enhanced by a cine X-ray unit, employing the image intensifier system, in the car. The clinical investigation of aircrew who show abnormal reactions in flight during high-speed manoeuvres can now be undertaken in safety.

I am indebted to the Director General of Medical Services, R.A.F., for permission to publish this article.

SEMICONDUCTORS: NO MAN'S LAND BETWEEN METALS AND INSULATORS*

By R. W. DOUGLAS

Research Laboratories of The General Electric Co., Ltd., Wembley

THE crystal detector in the early wireless set consisted of a thin wire or a cat's whisker pressed on to a piece of one of the materials now known as semiconductors. The peculiar properties of this class of materials are such that they cannot be considered either as metals or insulators, but as lying somewhere in the no man's land between the two.

A good example of these properties is provided by the electrical conductivity. If a metal wire is used to complete an electric circuit containing a lamp, the lamp will light but will dim slightly as the metal is heated. If the wire is replaced by a bar of a semiconductor, the lamp will not glow until the bar is heated. It is clear, therefore, that a metal conducts electricity far more easily than a semiconductor, although the conductivity of the latter increases with temperature while that of the metal decreases.

To find an explanation for these phenomena, some knowledge of the basic physics of the solid state is required. The modern model of the atom is now well known: a number of electrons revolve in orbits around a central nucleus, each orbit representing a permitted energy-level. This alone does not explain why, when a multitude of such atoms are brought close together to form a solid, the electrons may appear free to wander and to conduct electricity as in a metal, whereas in an insulator such as sulphur no such electrons appear to exist, and in a semiconductor they only appear on heating.

By studying gases, in which the individual atoms are still very far apart, a clear picture is obtained of the behaviour of each atom in isolation. If an electric current is passed through the gas a coloured glow appears, the colour of which is characteristic of each gas. The electric field has provided the outer

electrons in the atoms with sufficient energy to jump into more energetic orbits. When they fall back again to their original orbits, they give out a fixed quantity of energy which appears as visible radiation of a particular colour. This is the explanation of the characteristic colours of the argon, neon and helium discharges. A particular mercury vapour discharge lamp can be constructed which emits ultra-violet radiation strongly and, although this is invisible to the eye, it can be detected by a fluorescent screen. If now a small quantity of mercury vapour is inserted between the mercury discharge tube and the screen, this ultra-violet radiation will be completely absorbed again. In other words, the radiation emitted by electrons falling from high- to low-energy orbits has provided exactly the right amount of energy to complete the reverse process in another quantity of the same gas.

In the same way, semiconductors can be shown to absorb radiation. If a series of films of different semiconductors is inserted between a source of radiation, which passes through a prism so as to provide a visible spectrum, each film will cut off a different amount of the spectrum, beginning at the less energetic, that is, the red end. Further, the semiconductor, germanium, will cut off all visible light, but will transmit only infra-red radiation, the presence of which can still be detected by using a thermopile.

For each material the different frequency of light absorbed can be related to an electron jump, just as with mercury vapour. The difference between a solid and a gas, however, is that the solid absorbs all frequencies greater than a certain minimum, whereas the gas absorbs only the frequency corresponding to the energy required to excite an electron from one orbit to another. Instead of fixed orbits in the atomic model of the gas, which can be represented by thin lines, the model for the solid has broad bands of either permitted or forbidden energies which the electrons can or cannot inhabit. This change is due to the fact that, as the atoms are brought closer together to form the solid state, the isolated orbits begin to overlap and to form a series of bands (Fig. 1).

In a metal, one band which arises from occupied orbits overlaps a band which is normally unoccupied. The electrons from the occupied band can then always move up into other energy-levels. When now an electric field is applied, the small additional amount of energy supplied can be absorbed by providing the electrons with more energy.

In semiconductors and insulators, the bands do not overlap, that is, a band occupied by electrons

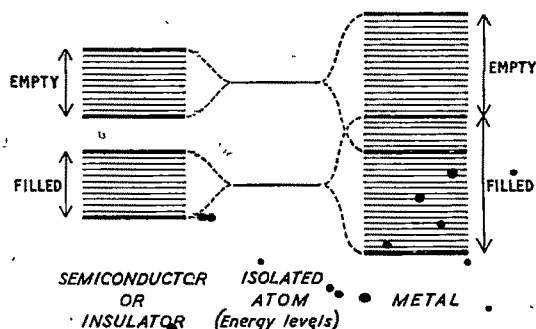


Fig. 1. Energy bands in metals and semiconductors

* Substance of a Friday Evening Discourse at the Royal Institution on May 13.

is separated from an unoccupied one by a region of energies which the electrons are not allowed to possess. If some radiation of sufficient energy falls on one of these materials, it will be absorbed by an electron which can then jump from the full band into the empty, or conduction, band. If the radiation has insufficient energy for this, it passes through without being absorbed. If the forbidden energy gap is not very wide, enough energy for the jump may be provided in the form of heat, which explains why the germanium bar conducts electricity only when heated.

From the width of the forbidden energy gap, it is possible to calculate the number of electrons which will appear in the empty band at any given temperature.

Material	Energy gap	Electrons/c.c. (room temp.)
Metal	—	10^{23}
Germanium (semi-conductor)	0.72 eV.	10^{13}
Diamond (insulator)	6.06 eV.	10^{-33}

The decrease in the electric conductivity of a metal with increasing temperature is due to the increased number of collisions between the conducting electrons and the atomic cores. The vibration of the heavy atomic cores increases with temperature, thus increasing the probability of these collisions and so slowing down the conducting process. In a semiconductor, however, the number of conduction electrons increases so rapidly with the temperature that this effect far outweighs any reduction in conductivity caused by these collisions. Another effect also comes into the picture. When an electron is excited from the filled band, it leaves a hole behind. These holes behave exactly like positive charges and thus, for each excited electron, two current carriers are actually produced.

Another way of producing additional current carriers in a semiconductor is by introducing impurities. From the Periodic Table of the elements, it is known that, whereas diamond, silicon and germanium have four outer electrons (the only ones relevant to this discussion), beryllium, aluminium, gallium and indium have three each, and nitrogen, phosphorus, arsenic and antimony have five each. The presence of one atom of arsenic in a bar of germanium therefore introduces a spare electron, which becomes so loosely tied to its parent atom that very little energy is needed to separate it. This can be denoted by putting an extra level in the empty energy band, lying just below the original upper limit of that band. Electrons will, therefore, jump readily from this level into the conduction band. Similarly, the introduction of an atom of, say, gallium, will produce a tendency for that stranger atom to acquire an electron from the surrounding germanium. The extra energy-level will then be just above the upper limit of the original filled band. The energy required to move an electron into this new level is small, so that, even at room temperature, electrons from the filled band can jump into it, leaving behind a positive hole. In both cases, the conductivity of the material has been increased; but, depending on the type of impurity introduced, the semiconductor will show rather different electrical behaviour.

If a wire is connected to germanium containing arsenic impurity (*n*-type semiconductor), with a galvanometer in the circuit, and the wire is heated, the galvanometer deflection is in the opposite direction

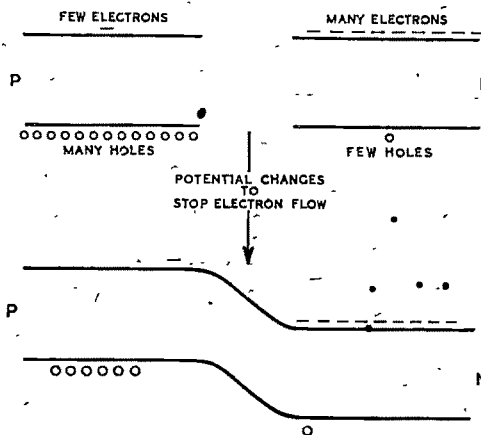


Fig. 2. *p-n* junction; no potential applied

from that obtained using germanium with indium impurity (*p*-type semiconductor). In order to travel from the wire into the *n*-type material, electrons need to absorb energy in the form of heat, so that the junction will cool down. When the wire is heated, therefore, a current will tend to flow in such a direction as to cool the junction. At the junction of the wire in the *p*-type material, on the other hand, there is an evolution of heat as the electrons from the wire give off energy on entering the semiconductor, and a current in the opposite direction will be produced on heating the wire.

If now a junction is made between *n*- and *p*-type materials, electrons will tend to spill from the former to the latter. This produces a change in the potential of the *p*-type material until the number of electrons jumping one way across the junction exactly equals those travelling in the reverse direction (Fig. 2). By connecting a battery across this junction device, different effects are obtained according to the direction in which current is made to flow. In one direction, the flow of electrons across the junction is reinforced, so that very large currents are obtained. In the other, the current will remain constant regardless of the applied voltage. This, of course, means that the device acts as a rectifier, behaving with a very high resistance in one direction and a very low resistance in the other (Fig. 3).

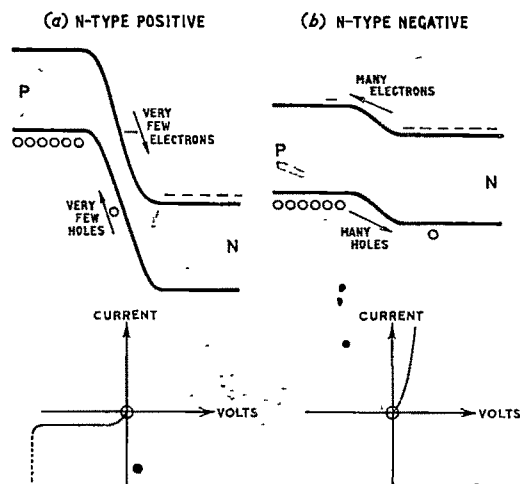


Fig. 3. *p-n* junction; potential applied

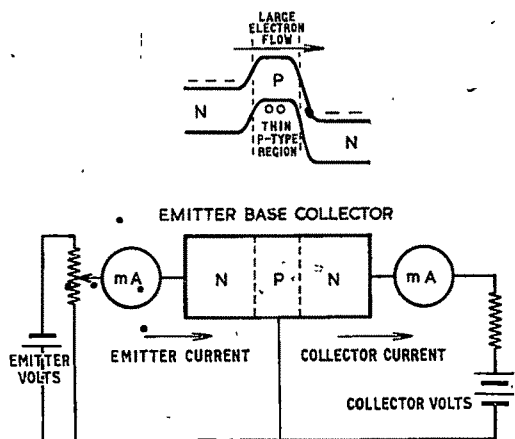


Fig. 4. Crystal triode (n-p-n junction transistor)

Suppose now that a thin piece of *p*-type material is sandwiched between two pieces of *n*-type, and two batteries are connected so that one *p-n* junction has a high resistance and the other a low resistance (Fig. 4). If the *p*-type semiconductor is thin enough, nearly all the current from the low-resistance junction appears in the high-resistance junction circuit. We can thus produce amplification, since a small change in current in the one part of the circuit can be produced by a small voltage. The same small change of current will appear in the high-resistance circuit and produce a large change in voltage there.

A knowledge of the basic physics of these semiconducting materials has thus led to the development of new circuit devices; the advantages of these crystal rectifiers and amplifiers are already well known, and their applications are increasing daily.

THE MUSEUM OF ENGLISH RURAL LIFE

By J. W. Y. HIGGS

Keeper

AT the end of April the Museum of English Rural Life was opened to the public by Sir Keith Murray, chairman of the University Grants Committee.

The Museum was established by the University of Reading early in 1951 as a national centre for the study of material connected with the history of the countryside. The history of farming and rural life has long been a neglected subject, and the rapid technical advances of the past few years have made it more than ever necessary to save examples of the equipment of the past before it is too late. From the beginning, however, the aim has been to create something much more comprehensive than merely a collection of material—to make in effect a university department which would be actively engaged in research and advisory work, and which as it developed would gather together an invaluable 'library' of information on every aspect of the subject. The Museum represents the first attempt by any university in Great Britain to make a serious study of rural culture, and to form a national reference collection which as it grows should be of immense value to students, to specialists and to other museums. A

very high standard in the study of the whole subject of folk culture has been set by the many excellent museums in Scandinavia which have been in existence for many years. It is our hope at Reading that we may be able to follow the general pattern and example of such important institutions as, for example, the Nordiska Museum at Stockholm. It is to be regretted, however, that the work did not begin some twenty years earlier, for much that was of value has already been irretrievably lost.

Up to the present, some four thousand exhibits have been gathered together from all over England; and of necessity during the first four years much time has been devoted to the classification, cataloguing and preserving of these exhibits. The collection is, however, already beginning to be representative, and ranges over many subjects from farming and the rural crafts to domestic life and the social life of the village community. It is not at the present time possible to display to the public more than a selection of the exhibits, though those on view present a fair cross-section and the displays will from time to time be changed. The reserve collections are, however, available for study by specialists and for loan to other museums and institutions. It will also be some time before it is possible to display the many larger items in the collection. This is unfortunate, because many of them are of considerable interest; for example, there is an important collection of four-wheeled wagons. They are rapidly disappearing from the countryside and the art of making them will soon be lost completely; in fact, in the counties of Oxfordshire, Berkshire and Buckinghamshire there is only one man alive who has ever made a wagon. It is hoped that a study of the design and regional variations of these will form the subject of the first handbook to be published by the Museum. There is also a good collection of ploughs, which illustrates clearly the types made by local craftsmen to suit the needs of local soils and conditions. Included in this collection is one of the earliest tractor ploughs, which dates from 1910.

Starting the Museum from nothing has provided a unique opportunity of devising a cataloguing system which, it is hoped, will ensure that an adequate and complete record is compiled for each exhibit. It is all too easy to collect folk material without collecting sufficient background information to explain its proper use and the place it occupied in the system to which it belonged. England is a country of wide variation in farming methods, and the same tool may be used for quite a different purpose in different parts, or conversely quite different tools may be used for exactly the same purpose. The recording system is based on that used in many Scandinavian museums, the main information being recorded on a large index card which incorporates a photograph of the object on the back. It is therefore possible for the student to make a preliminary study of his subject without having to seek at the outset the objects themselves. The process of photographing each individual object has already amply justified the cost, and the fact that the Museum possesses a comprehensive photographic index of its material is already proving useful to other workers in the field. It is intended in time that the catalogue should incorporate material found in other museums in England. Close contact is maintained with museums which have rural collections, and a number have already expressed their desire to participate in such a scheme.

As mentioned earlier, the work of the Museum is by no means limited to the collection of the objects themselves. Every attempt is made to obtain accounts of how processes or operations were carried out. These are sometimes provided by people who themselves remember them, or by the Museum's own staff or collaborators interviewing members of the older generation who can provide useful information. It is intended in the future to expand this work considerably. Already an attempt is being made to photograph sequences of crafts or farm tasks that are becoming rare, and eventually it is hoped to record some of these by making short record-films. It is hoped, too, to prepare questionnaires on certain subjects and to enlist the aid of local historians in compiling them. All these tasks will serve to make the exhibits themselves more useful and to provide a more adequate background to the subject.

The speed with which the Museum has become known is very gratifying. Already it is beginning to be used by many people, and it is clear that the belief of its founders in the need for a specialist museum of this type is amply justified. It is still, however, after four years, at the very beginning of the road; a great deal remains to be done before it can achieve fully the aims which it has set itself. If, however, it continues to receive the enthusiasm and support and assistance which it has met on all sides, its future is assured.

INTERNATIONAL CONFERENCE ON MARINE BIOLOGICAL LABORATORIES

FOLLOWING a decision of the Bureau of the International Union of Biological Sciences, an International Conference on Marine Biological Laboratories was held in Rome during April 18-22, immediately after the meeting of the General Assembly of the International Union. The Committee appointed to take charge of the organization of the Conference consisted of Prof. Robert W. Hiatt (University of Hawaii) as chairman, with Prof. J. Runnström (University of Stockholm) and Prof. C. M. Yonge (University of Glasgow) as members. The Conference was attended by official participants from Canada, Denmark, Egypt, France, Germany, Great Britain, Italy, Japan, Norway, Sweden, the United States and Yugoslavia, while the following additional countries were represented by observers: Austria, Belgium, Finland, India, The Netherlands and Switzerland.

Following an introductory address on the historical development of marine biological laboratories by Prof. C. M. Yonge, the Conference heard accounts by its members of existing marine laboratories throughout the world. Under the leadership of the official participants, discussions then took place covering the whole field of activities of these laboratories. These included the relations of fundamental and applied research with particular reference to fisheries research, the relationship between marine biological laboratories and the physical aspects of oceanographic research and the role of marine laboratories in graduate and postgraduate education. In addition, the relations between marine laboratories and universities and government departments or other institutions was discussed.

Much time was naturally spent dealing with questions of financial support, coming as this may from so many sources, although becoming increasingly dependent on government funds. It was pointed out in later discussions dealing with publication that there are at least a hundred publications devoted wholly or mainly to marine biology (including fisheries), while this number would be more than doubled if journals commonly used for publishing results of marine biological research together with current reports on marine expeditions and surveys were included. The manifold problems of equipment and the technical difficulties of running research aquaria, with the design of research vessels and their gear, occupied much time in the Conference.

Leading naturally from the above topics, which had revealed so much diversity of aim and such varying range of equipment and facilities, the Conference came logically to a consideration of the preparation of an International Directory of Marine Laboratories. No existing directory is in any way comprehensive or covers institutions recently established or which have notably increased their facilities since the Second World War. Finally, at this first preliminary international gathering of marine biologists, the need for some permanent organization was discussed. Not only was this considered necessary, but the need for some central organization from which a bulletin of technical information could be circulated was stressed. At the same time, there was felt to be no reason to increase the number of journals dealing with marine biology but rather to reduce these by fusion of the smaller publications, while the advantage of a laboratory distributing its work in the form of collected reprints was stressed.

Much interest was shown in impending developments, which in Europe include the possibility of the foundation of a marine station at Elsinore, together with much expansion and co-operation of work within the four Scandinavian countries. In Germany the laboratory at Heligoland is to be rebuilt, and it is hoped that the Belgian station at Ostend, destroyed in 1940 and now replaced provisionally, will soon have new buildings. In tropical waters, the activities of the Colonial Fisheries Advisory Committee in establishing laboratories at Freetown, Zanzibar and Singapore were noted with much interest, as were the activities of the University College of the West Indies at Jamaica. The establishment of a second Egyptian marine station near Suez and of laboratories at Curaçao and in Madagascar were reported, together with new Japanese activities in the Bonin Islands. The most obvious gaps in the distribution of marine biological stations appeared to be in parts of the Indian Ocean, notably around Karachi and Ceylon and in the East Indies and also around South America, although there are encouraging activities both in Brazil and in Chile.

After five days of sustained discussion, which all who took part felt fully justified this Conference, the proceedings suitably ended by a visit to the Stazione Zoologica at Naples. There participants and observers were received and entertained by Dr. Reinhard Dohrn and Dr. Peter Dohrn, respectively son and grandson of the founder of this parent institution of all marine laboratories. The great activity of this laboratory, now more than eighty years old, was felt both as a justification of past endeavours and as an encouragement for those of the future.

C. M. YONGE
F. S. RUSSELL

OBITUARIES

Engineer-Captain Edgar C. Smith, O.B.E., R.N.

To readers of *Nature*, the name of Engineer-Captain Edgar C. Smith has been familiar for more than thirty years as that of a scientific biographer and a historian of engineering who combined to an unusual degree a love of precise detail and the ability to present it in arresting perspective with a notable economy of words. In this, however, his writing did no more than reflect his own vivid and forceful personality, and did it so effectively that, even to those who knew him only as a name in print, the news of his death, on March 13, must have brought a sense of individual loss. Those whose good fortune it was to enjoy his friendship are acutely conscious that they have lost something very precious.

No man is indispensable, though every man is in some way unique—a thesis to which Smith was always ready to subscribe; but few historians have laboured to such good purpose as he did in collating and recording the engineering history of the Royal Navy, and assuredly few men forged more numerous ties of real affection in pursuing their researches. His father, a schoolmaster who was living in Newport Pagnell when Edgar Charles was born on May 5, 1872, was keenly interested in science for its own sake, and the school at Gravesend to which he transferred in the following year soon established a reputation for the teaching of elementary natural philosophy. Smith grew up, therefore, in an atmosphere of scientific experiment and inquiry, and was further stimulated by a year spent at Finsbury Technical College under John Perry and Silvanus Thompson—though, as he admitted in later years, he did not feel that stimulus at the time, finding the curriculum rather beyond his power to absorb.

He entered the Navy as a temporary assistant engineer in 1895, having previously acquired a good knowledge of engineering practice in various engineering works, mainly in the West of England, and something of the theory, by attending classes in the Merchant Venturers' College at Bristol. He spent twenty-seven years in the Royal Navy, serving in battleships, cruisers and destroyers, in H.M.S. *Britannia* as an instructor, and in several of the Royal dockyards, retiring in 1922 on reaching the age of fifty. Nearly twenty years earlier he had begun to collect biographical material about eminent scientists and engineers of all nationalities and, on retirement, he set himself to collate it systematically and to fill the gaps that the process revealed. At the same time, he embarked on the prodigious task of establishing personal contact with the whole of the retired engineer officers of the Royal Navy, obtaining their personal reminiscences, and checking the details by direct references to Admiralty records, many of which were wholly unexplored by historians. By this means he was able, after several years of laborious work, to build up a fairly complete picture of the origins and growth of the Engineering Branch of the Royal Navy and to present it in a valuable series of papers to the Newcomen Society (of which he was president in 1937–38), in various articles in the technical and scientific press, and in his book, "A Short History of Naval and Marine Engineering", published in 1938.

Concurrently, he was maintaining a steady flow of contributions to *Nature*, including an annual article on scientific centenaries and other anniversaries,

which culminated in a series of articles on "Britain's Scientific Shrines", published in Festival of Britain Year (1951). It was not his last contribution; but it was the most important connected series that he compiled in the biographical field, and stands as a monument to his remarkable industry in collating data and verifying facts. More recently, increasing infirmity prevented him from undertaking anything in the nature of field-work or other physical exertion; but his mind remained as vigorous and his letters as crisp as ever, and his contributions to the deliberations of the Newcomen Society's Council, of which he had been a member since the Society was formed in 1920, were frequent and invariably to the point. Others, no doubt, will continue the historical work that he began; but, so far as the Engineering Branch of the Royal Navy is concerned, it is improbable that they will be able to add materially to the foundation that he laid.

J. FOSTER PETREE

Prof. D. Y. Solandt

THE death occurred on March 30, at the age of forty-eight, of Donald Young Solandt, professor and head of the Department of Physiological Hygiene and professor of physiology in the University of Toronto.

Dr. Solandt was born in Ottawa, Canada, the elder son of Mrs. Solandt and the late Rev. Donald McKillop Solandt. Following his secondary schooling, he entered the University of Toronto, with which he was associated, first as a student and then as a member of the staff, until the time of his death. After graduating in medicine in 1933, Dr. Solandt carried on outstanding postgraduate work in the University of Pennsylvania under the direction of Dr. D. W. Bronk. Later he continued his graduate work in Britain in Prof. A. V. Hill's laboratory at University College, London, and obtained his Ph.D. degree from the University of London in 1936. In 1944 he received his diploma of public health from the University of Toronto.

During the Second World War, Dr. Solandt served for three years in the Naval Medical Research Division of the Royal Canadian Navy. His outstanding work, particularly in connexion with protection of night vision, was acknowledged by the award of the Medal of Freedom with Bronze Palm by the Government of the United States. Dr. Solandt's rank was that of surgeon commander.

Dr. Solandt was an outstanding authority on the physiology of muscle and made many significant contributions in diverse fields of research. He was mainly interested, in recent years, in the field of biophysics as applied to physiology and public health. His publications were numerous and appeared in medical and biophysical journals in Britain, Canada, the United States and elsewhere.

Dr. Solandt was a valued member of many committees of the National Research Council of Canada. He also served on the Advisory Committee of the Department of National Health of Canada and the American Public Health Association. He was an honorary Fellow of the American Medical Association, a Fellow of the Royal Society of Canada, and a member of many other scientific bodies.

Dr. Solandt was an exceptionally talented and versatile person. His reading covered a very wide field, and his fund of knowledge outside the realms of science never ceased to amaze his colleagues. His

vigorous intellect and personality and his loyal friendship will always be remembered.

In 1936 Dr. Solandt married Barbara Garrard, a science graduate of Cambridge whom he met while working in London. He is survived by his widow and three daughters, Barbara, Sandra and Diana.

CHARLES H. BEST

Mr. C. H. Dinham

CHARLES HAWKER DINHAM, whose death occurred suddenly on February 15, had been a member of the scientific staff of the Geological Survey of Great Britain for the exceptionally long period of forty-three years. Before starting his Survey career in the Edinburgh office of the Survey in 1910 he had distinguished himself at Haileybury as a classical scholar, and became head of the school. Afterwards he was an Exhibitioner at Magdalen, Oxford, where he studied both classics and science.

He gained much experience of Carboniferous geology in Scotland, and also served in Sutherland for a time. A short spell of field-work in Northumberland resulted from his temporary transfer to Newcastle upon Tyne after the First World War; but he returned to Scotland again on promotion to the rank of district geologist, in 1922. In 1927 he was again moved to England, this time to the old Survey headquarters in Jermyn Street, London. Here he took

charge of a unit working in the Midlands and Eastern England. This post he held until his sixty-second year, when he retired, but was re-engaged in a lower rank, that of principal geologist, for special geological duties. This was possible under the scheme now operating within the Civil Service by which the services of experienced officers can be retained after they reach the normal retiring age. Dinham continued to serve until, at the age of seventy, final retirement from the Geological Survey became inevitable. Even so, his abiding interest in geology impelled him to carry on, even after he had more than earned the right to complete leisure; and he continued to attend the Geological Survey offices fairly regularly until his death this year. He was, in fact, on his way to South Kensington when the end came.

Dinham lived a life of selfless devotion to the Geological Survey. He made no outstanding contributions to geological science; but it is men such as Dinham, carrying out the day-to-day work of the Survey without thought of personal advancement, who enable it to fulfil its duties to the public. Dinham combined with a very wide knowledge of British geology and exceptionally long experience of Survey work, a pleasant, if retiring, personality. He was very well liked by his colleagues, who knew that they could always turn to him for advice and help which would be freely given. He is survived by his widow and three children.

NEWS and VIEWS

Queen's Birthday Honours

THE following names of scientists and others, associated with scientific work appear in the Queen's Birthday Honours List:

Baronet: Sir George Nelson, chairman and managing director, English Electric Co., Ltd.

K.B.E.: Dr. Alexander Fleck, chairman of Imperial Chemical Industries, Ltd., for services to the Ministry of Fuel and Power; Arthur H. Gosling, director-general, Forestry Commission; Sir Harold Spencer Jones, Astronomer-Royal; Major-General Jack E. S. Stevens, chairman of the Australian Atomic Energy Commission.

Knights: Harold Bishop, director of technical services, British Broadcasting Corporation; Dr. B. Ifor Evans, provost of University College, London; Edward H. B. Lefroy, for services to agricultural and pastoral industries in Australia; Sangarapillai Pararajasingam, for services to agriculture in Ceylon; John P. Tivey, for services to engineering, science and industry in Australia; Hugh E. Watts, lately H.M. chief inspector of explosives, Home Office.

C.B.: J. N. Ritchie, chief veterinary officer, Ministry of Agriculture, Fisheries and Food; Dr. N. C. Wright, chief scientific adviser, Ministry of Agriculture, Fisheries and Food.

C.M.G.: J. R. Dridan, engineer-in-chief, Engineering and Water Supply Department, South Australia; W. A. Gunn, for services to the pastoral industries in Australia; R. W. Kettlewell, director of agriculture, Nyasaland; H. A. W. Morrice, irrigation adviser and director of irrigation, Sudan Government.

C.B.E.: Dr. A. B. D. Cassie, director of research, Wool Industries Research Association; A. E. Childs, director of chemical defence research and develop-

ment, Ministry of Supply; K. A. C. Creswell, for services to the study of Muslim architecture and archaeology; Dr. J. V. Dunworth, head of the Reactor Physics Division, Atomic Energy Research Establishment, Harwell; A. R. Entrican, director of forestry, New Zealand; W. Fairely, chief civil engineer, Office of the Crown Agents for Oversea Governments and Administrations; G. E. Foxwell, consulting fuel technologist; G. Gibson, chief mechanical engineer, East African Railways and Harbours; Dr. R. T. B. Green, senior bacteriologist, Institute for Medical Research, Federation of Malaya; R. A. Hammond, director of veterinary services, Kenya; Dr. W. C. Moore, director of the Plant Pathology Laboratory, Ministry of Agriculture, Fisheries and Food; Dr. F. G. Morgan, director of the Commonwealth Serum Laboratories, Australia; Dr. D. D. Pratt, director of the Chemical Research Laboratory, Department of Scientific and Industrial Research; Prof. H. G. Robinson, emeritus professor of agriculture, University of Nottingham; Prof. M. L. Rosenheim, professor of medicine, University of London; Prof. J. L. Thomson, professor of mechanical engineering, Royal Military College of Science, Shrivenham; P. B. Walker, deputy chief scientific officer, Royal Aircraft Establishment; J. L. Wilson, for services to the pastoral and agricultural industries in Australia; Miss E. L. Younghusband, lecturer in social science, London School of Economics, chairman of the West London Juvenile Court.

Public Health and Social Medicine at Edinburgh: Prof. F. A. E. Crew

PROF. F. A. E. CREW, who is retiring at the end of this session from the chair of public health and social medicine in the University of Edinburgh, has played

a very notable part in the development of British biology during the past three or four decades. The period about the end of the First World War witnessed an almost revolutionary change in biological outlook—a broadening of interest from the purely morphological to embrace also the physiological, developmental and genetical fields which are now commonly known as 'experimental biology'. Crew, who had served during 1914–18 in India and France, returned to an assistantship in the Department of Natural History, Edinburgh, and threw himself with great vigour into this movement. He was the first editor of the *Journal of Experimental Biology*—now one of the most flourishing biological journals. He also played a considerable part in founding the Society for Experimental Biology, which will celebrate its hundredth meeting this summer at Cambridge.

Crew's own work was in genetics, which was at that time even more of a 'Cinderella' among the biological sciences than it is to-day. Crew's enthusiasm and gift for organization brought into being first a relatively modest sub-department, but after some years this grew into a large Institute of Animal Genetics attached to the University of Edinburgh. During the 'thirties, under Crew's guidance, this was not only undoubtedly the leading department of genetics in the zoological field, but also fulfilled the functions of a national institute of research in animal breeding. A fitting tribute to the value of his work was made when Crew was elected president of the Seventh International Congress of Genetics, held in Edinburgh in 1939. Alas, war broke out while the conference was actually in session, and the meetings had to be abandoned. Crew's steadiness and qualities of leadership in this most difficult situation made a great impression on the international gathering, which few of those who were present have forgotten.

During the Second World War, Prof. Crew served as director of medical research, War Office, and rose to the rank of brigadier. At the close of hostilities he found energy enough to open for himself a new civilian career, returning to Edinburgh this time as professor of social medicine and public health. As after the First World War, he again found himself taking part in the first phases of the development of a new movement of scientific thought, and once again he has left a lasting memorial in the form of a vigorous and flourishing department.

Dr. J. H. F. Brotherston

DR. J. H. F. BROTHERSTON, reader in public health in the University of London, has been appointed to succeed Prof. Crew. A graduate in arts and medicine of Edinburgh, Dr. Brotherston served during the Second World War as a medical officer in Iraq, Egypt and Sicily. He was wounded in action in 1943, but rejoined the forces in Belgium and Germany, reaching the rank of major. After the War, Dr. Brotherston took the diploma in public health of the University of London, gaining the first place in a large post-war class at the School of Hygiene and Tropical Medicine. He won a Rockefeller fellowship to the United States, where he made a valuable study of training methods in the schools of public health. This was accepted as a thesis for the Dr.P.H. of Johns Hopkins University. Since returning to Britain Dr. Brotherston has held appointments at Guy's Hospital and the London School of Hygiene. During the past five years, Dr. Brotherston has been director of a field-research study area in south-west Hertfordshire. The

large research project which he undertook was financed mainly by the Rockefeller Foundation and included investigations of the medical care of the elderly, both in hospital and in their own homes under the family doctor. Studies have been made under his direction of the incidence of health-needs in a sample of families with the object of discovering how these problems are dealt with in a new housing estate. The team of workers has also carried out reviews of the work of general practitioners, maternity and child-welfare services, school health and hospital services for groups of families. The work is intended to show the degree of co-operation between the services. Dr. Brotherston has published books and articles dealing with both historical subjects and with a wide range of problems of medical education. In his new appointment in Edinburgh he will have unusual opportunities for teaching and research in both the postgraduate and the undergraduate fields, and for co-operation with the social science departments within the University and the public health services of the city.

East African Agriculture and Forestry Research Organization : Dr. E. W. Russell

DR. E. WALTER RUSSELL, who has been appointed to succeed Sir Bernard Keen as director of the East African Agriculture and Forestry Research Organization, is at present reader in soil science in the University of Oxford, to which post he was appointed in 1948. After reading mathematics and physics at Cambridge, he became interested in soil science and spent a year with Prof. G. Wigner, of the Technical High School, Zurich, and some time with Prof. B. Polyer, of the University of Leningrad. He joined the staff of the Physics Department of Rothamsted Experimental Station in 1930 and at first his work was principally concerned with problems relating to soil structure and included studies of the absorption of liquids by clays and the mechanism of crumb formation. Arising from some of these investigations a year was spent with Prof. W. A. Patrick, of Johns Hopkins University, Baltimore, as a Rockefeller Fellow. Following on the investigations begun by Sir Bernard Keen at Rothamsted, he has been engaged for the past ten years in an extensive series of experiments on the effects of subsoiling and deep ploughing on crop production in Britain.

Since going to Oxford, his main field of research has centred around the reactions of soil organic matter with clay and soil particles and the behaviour of phosphates in soils. In collaboration with Dr. Scott Russell, who is in charge of the tracer laboratory of the Department of Agriculture, isotopic techniques have been employed in a preliminary analysis of some of the factors which limit the uptake of mineral nutrients from different soil types. Dr. Russell is a member of the Governing Body of the National Institute of Agricultural Engineering, a vice-president of the Institution of British Agricultural Engineers, secretary of the British Society of Soil Science since its formation in 1947 and president of Commission IV (Soil Fertility) of the International Society of Soil Science.

Technological Applications of Irradiation

THE United Kingdom Atomic Energy Authority has announced the formation of a Technological Irradiation Group at the Atomic Energy Research Establishment, Harwell. This Group will be equipped

with the largest sources of fission products in Europe and will have by the end of this year a 5,000-curie cobalt and a 5,000-curie caesium source. By the middle of next year these sources will be doubled, and mega-curie sources for irradiations will be available from fuel elements from a new reactor. It is planned to use for irradiations, machines such as linear accelerators to complement the irradiation programme. This new Group will investigate all possible uses for the millions of curies of fission products which will be available within a short time from British reactors. Already a number of promising applications are being investigated, such as the physical changes due to irradiation of a number of substances and especially those of plastics. Of great interest also is the sterilization of drugs and the possible extension of shelf-life due to radiation. Quite a number of chemical changes which are initiated by irradiation are being investigated already. This new Group will work closely with industrial concerns, and special arrangements are being made so that industry should profit to the fullest extent from this co-operation.

Professional Civil Servants

IN his speech at the opening of the tenth annual delegate Conference of the Institution of Professional Civil Servants on May 23, the general secretary, Mr. Stanley Mayne, quoted a recent statement by Dr. (now Sir) A. Fleck that in Britain we have only 64,000 scientists instead of the 90,000 we need. Mr. Mayne said that, in spite of repeated authoritative statements since the Barlow report on scientific man-power, made by the Advisory Council on Scientific Policy and others, there is no indication in the programme of either of the major political parties that it is realized that the supply of scientists and technologists is a major factor in national survival. Mr. Mayne referred also to the establishment in 1945 of the National Agricultural Advisory Service to ensure that the results of scientific research are brought immediately and directly before the industry by skilled interpreters, and he contrasted the prospects offered to the honours graduate entering on such a career with those open to the honours graduate in arts entering the administrative class of the Civil Service. He thinks that the Royal Commission on the Service should ensure that it is no less worth while taking up a scientific, professional or technical career in the Civil Service than it is to take up another type of career. It is also essential to make science teaching an attractive career, as well as to increase the number of science teachers, while facilities for more science students are required both in the schools and the universities. Although something has been attempted in regard to science teachers, Mr. Mayne suggested it was too little and too late; nor does he agree with the University Grants Committee that no further substantial increase in the number of university students can be expected in the immediate future without reducing university standards. We need a sharp improvement in educational facilities, he said, for the present extraordinary variation in educational opportunity in different parts of Britain represents lost opportunities of equipping the young people who, in a few years, will be running industries and conducting research. He thought that the Institution has a great responsibility for stimulating the more consistent and comprehensive thinking which is required about the minimum necessities for the economic survival, let alone the progress of Britain.

Cancer Chemotherapy National Committee in the United States

IN the belief that the state of knowledge of chemotherapy has advanced sufficiently to warrant a national voluntary co-operative programme of research and development for the treatment of cancer by drugs, a Cancer Chemotherapy National Committee has been formed in the United States, headed by Dr. Sidney Farber, scientific director of the Children's Cancer Research Foundation in Boston, with Dr. Kenneth M. Endicott, of the National Cancer Institute, Bethesda, Maryland, as the executive secretary. The sponsoring organizations are the American Cancer Society, the U.S. Atomic Energy Commission, the Damon Runyon Memorial Fund for Cancer Research, the Food and Drug Administration, the National Cancer Institute of the U.S. Department of Health, Education and Welfare, and the Veterans Administration. Representatives of these organizations met recently at the National Institutes of Health, Bethesda, to form the National Committee, and they also appointed an advisory group of six for liaison with the pharmaceutical and chemical industries. In addition, four technical advisory panels have been established and are meeting to assess the progress in cancer chemotherapy research and make recommendations for the future. These panels will cover the fields of chemistry, pharmacology, screening of chemical compounds through experiments on animals, and clinical studies. The sponsoring agencies are providing a small full-time staff, headed by Dr. Endicott, to administer the programme, organize an information exchange and give needed assistance to research scientists. The Committee, which including Dr. Farber consists of ten, will define the scope of the programme, develop general policies, assist in obtaining financial support for the work, co-ordinate the activities of the sponsoring organizations, and observe the rate of progress of the entire effort.

The Coffee Pot: a New Club in London for Young Professional Workers

MANY young men and women commencing professional jobs far from the towns in which their parents live find it difficult to meet others who share their interests. To meet the needs of such people, a new club has been opened in London—The Coffee Pot—directed by a committee composed largely of recent graduates and three or four senior members. The club is intended for younger members of the professions, particularly those who are not natives of London. Membership is open to men and women between the ages of nineteen and thirty. The subscription is £2 a year, and there is no entrance fee. There is an 'at home' at the Coffee Pot Club every Monday during 7.30–10 p.m., and there are restaurant and club lounge facilities on Mondays, Tuesdays, Thursdays and Fridays. It is hoped to open other such clubs in various towns, and there are schemes for a London Coffee Pot which will be open every day. Further information can be obtained from the Secretary, The Coffee Pot, 83 Chiltern St., London, W.1.

Origin of the *n*-Sound in Speech

IN his paper "Some Remarks on the Origin of the *n*-Sound" (Reykjavík, 1954), Prof. Alexander Jóhannesson, of the University of Iceland, expands, with special reference to the *n*-sound, the theory which, in these pages and elsewhere (see *Nature*, 166,

60; 1950), he and Sir Richard Paget have put forward as to the gestural origin of language. He draws evidence from six unrelated languages or language-groups (Indo-European, Hebrew, Turkish, Polynesian, Greenlandic and Chinese) in an attempt to show the element of meaning common to many words containing the *n*-sound drawn from these diverse sources. His evidence is selected (as in such an investigation perhaps it must be), and he considers his material under three headings: emotional sounds, nature sounds (that is, onomatopoeic sounds), and gestural sounds ("imitations of the shape or form of things in surrounding nature and of movement"). Not all linguists would agree with him, however, that these three kinds of sound represent successive stages in the development of human speech; or that the third kind, if it exists, can be recovered sufficiently to help in an understanding of the ultimate origins of language (if such an understanding is possible). (Prof. Jóhannesson's fourth 'stage' is the development of words with abstract meaning from those with concrete meaning.) That sounds of the first two classes exist in all languages no one will deny. Nor need we be surprised at the similarity between English 'nanny', Turkish *nini* (mother) and Greenlandic *an-ana* (mother); nor at that between English 'ting-a-ling', Turkish *tingir-tingir* (sound of metallic things knocking together), and Archaic Chinese *ting-ning* (a small bell). The words collected (under the heading of emotional sounds) showing the connexion of the *n*-sound with meanings of "blowing" or "breathing" (and hence "the soul") are impressive in number. But when under the gestural meaning of 'curved', 'round', 'swollen' are collected words having such diverse meanings as 'grave', 'conceal', 'cover', 'ivy', 'hair', 'be dark', 'out', 'neck', 'cub', as well as more obvious ones like 'fat', 'tumour', one wonders whether this is not all too remote ever to be convincing.

University Grants Commission Bill in India

THE Government of India has introduced a Bill in the Lok-Sabha called the University Grants Commission Bill, 1954; this has now been referred to a Joint Select Committee of Parliament. It has been claimed that such a Bill was long overdue as universities in India have greatly suffered in the past from neglect (*Sci. and Cult.*, 20, No. 9; March 1955). Except for the Universities of Delhi, Banaras, Aligarh and, lately, Visva-Bharati, where financial responsibility rests on the Central Government, other universities, many of which are much larger and much older than these, have not received any considerable funds from the central government. They have to rely on funds provided by the respective States and these are far below their requirements. With the increasing tempo of national development in all spheres and with the growth of new knowledge in science and technology all over the world, the universities in India have to enlarge their field of education and research if they are to discharge their responsibilities to the nation. A Bill, therefore, which would enable the formation of a Statutory University Grants Commission, supplied with adequate funds by the Government of India and clothed with appropriate authority, is most welcome.

Durban Museum and Art Gallery: Annual Report

THE annual report for the years 1953-54 of the Durban Museum and Art Gallery (pp. 15; 1955) records the opening of the Old House Museum by the

Administrator of Natal, Mr. D. G. Shepstone, on June 12, 1954. This Museum is devoted entirely to the preservation and display of historical material associated with the Province of Natal. The 'Old Durban' Room in the central Museum forms the nucleus, and the various and extensive collections gathered together by the South African National Society (Durban Branch) are likewise centred at the Old House. The year also witnessed the virtual completion of the new gallery of South African birds with its complement of thirty-six habitat groups.

International Society for Human and Animal Mycology

THE International Society for Human and Animal Mycology was founded last year by a group of scientific workers from ten countries. Its objects are to bring together qualified persons interested in the study of fungi living on humans and animals; to encourage the formation of regional groups of these persons; to organize meetings of the members of the Society on the occasion of international congresses; and to publish, as soon as possible, a bulletin devoted to human and animal mycology. The committee of the Society is as follows: *President*, P. Redaelli (Milan); *Vice-Presidents*, C. W. Emmons (Bethesda, Maryland), G. T. Ainsworth (Exeter), P. Negroni (Buenos Aires) and G. Segrétain (Paris); *General Secretary*, E. Vanbreuseghem (Antwerp). Persons wishing to join the Society should write to the General Secretary at the Institut de Médecine Tropicale, 155 rue Nationale, Anvers.

University of Glasgow

THE following appointments have been made in the University of Glasgow: *Lectureships*, P. de Mayo, K. H. Overton and R. P. A. Sneedan (chemistry) and A. M. Andrew (physics (electronics)); *Imperial Chemical Industries, Ltd., Fellowships*, E. Corinaldesi and P. V. March (natural philosophy) and E. Seoane (chemistry); *Nuffield Fellowships in Genetics*, C. G. Elliott (a reappointment) and Etta Kafer. Dr S. C. Curran has resigned from the Department of Natural Philosophy in the University on his appointment as head of the Division of Radioactivity, United Kingdom Atomic Energy Authority, and Dr A. N. MacPhail from the Department of Public Health, on his appointment to the chair at University College, Khartoum. Work has been commenced in the University on the extensions to the engineering buildings that are to occupy ground most of which was formerly occupied by the old chemistry buildings.

Lady Tata Memorial Trust: Awards

THE following new awards have been made by the Lady Tata Memorial Trust for research on leukaemia and allied diseases during the academic year 1955-56: *Scholarships (whole-time or part-time)*, Prof. H. G. Teir (Department of Pathology, University of Helsinki) and Dr C. G. V. Wassatjerna (Department of Haematology, Maria Hospital, Helsinki); *Personal grant*, Mr. Stanislaw Joseph (Department of Human Anatomy, University of Oxford). In addition, a block grant has been made to the Social Medicine Unit, University of Oxford (Dr Alice Stewart, director), for the cost of a pilot inquiry into possible environmental factors in the aetiology of leukaemia in man. Various awards first made to the following in previous years (see *Nature*, 171, 1098 (1953), and 173, 1170 (1954)) have been renewed for a further year:

Dr. J. Kieler (Copenhagen), Dr. J. Nordmann (Paris), Dr. A. Sreenivasan (Bombay), Dr. F. Kissmeyer-Nielsen and Dr. N. A. Stenderup (Aarhus), Dr. J. Ringsted and Dr. J. Rygaard (Copenhagen), and Dr. Maxime Seligmann (Paris).

Conference on the Physiology of the Invertebrates

A CONFERENCE on "Recent Advances in the Physiology of the Invertebrates", sponsored by the United States National Science Foundation, the Tektronix Foundation and the University of Oregon, will be held at Eugene, Oregon, during September 12-16. The conference was initiated by A. W. Martin, of the University of Washington, and has been organized by a committee composed of Martin, L. H. Kleinholz (Reed College), B. T. Scheer (University of Oregon) and T. H. Bullock (University of California). Eugene was selected as the meeting place because the administrative body of the University of Washington refused permission for a lecture by Dr. J. Robert Oppenheimer. The conference will consist of a series of reviews of recent work in invertebrate physiology, followed by informal discussions, the invited speakers including, besides the committee members and others, F. A. Brown, jun., J. S. Pringle, J. D. Robertson, T. H. Waterman, C. A. G. Wiersma and K. M. Wilbur. The papers will be published by the University of Oregon. A visit will be made to the Oregon Institute of Marine Biology at Charleston. Further information can be obtained from Prof. B. T. Scheer, Department of Biology, University of Oregon, Eugene.

Twelfth Congress of the International Association of Applied Psychology

THE twelfth congress of the International Association of Applied Psychology will be held in London in the University Senate House and in Birkbeck College, both of which are in Malet Street, London, W.C.1, during July 18-23, under the presidency of Dr. C. B. Frisby. Besides a large number of symposia on specialized topics and the reading of individual papers, four general lectures will be given as follows: Sir Frederic Bartlett (Cambridge), on timing—a fundamental character in human skill; Prof. L. L. Thurstone (North Carolina), on the theory and application of a subjective metric; Prof. C. Pellizzi (Florence), on the European Productivity Agency; and Dr. E. Mira y Lopez (Rio de Janeiro), on the influence of foresight and attitude on mental output. Visits will be made to a number of psychological organizations and hospitals in London, Cambridge, Oxford and Windsor. Further information can be obtained from the secretary of the congress, Mr. Alec Rodger, 14 Welbeck Street, London, W.1.

Canadian Association of Physicists: Tenth Annual Congress

THE tenth annual congress of the Canadian Association of Physicists will be held in Toronto during June 20-24 in conjunction with the June meeting of the American Physical Society; the last three days of the congress will be devoted to the programme of the latter body. On June 20 the Canadian Association will hold a symposium on radiations as applied to medicine, under the chairmanship of Prof. J. K. Robertson (emeritus professor of physics, Queen's University, Kingston, Ontario), and on the following day there will be another symposium on "Physics in Industry", under the chairmanship of Dr. L. Kerwin (Laval University,

Quebec). On the same day Dr. Kerwin will give his address as president of the Association, his subject being "The Next Decade for C.A.P.", and in the evening Dr. R. T. Birge (president of the American Physical Society) will give an after-dinner address on "Science and Pseudo-Science".

Fourth National Clay Conference in Pennsylvania

THE Fourth National Clay Conference will be held in the Pennsylvania State University at University Park during October 10-13, this being the first time that it has met in the Eastern United States. The period coincides with the centennial celebration of the Pennsylvania State University, and arrangements have been made for several scientific workers from Europe and Asia to attend and present papers describing work in their own countries. In the past the Conference has attracted a very diverse group of scientists ranging from colloid and ceramic chemists to mineralogists and soil scientists. Further information can be obtained from the chairman of the local committee, Prof. T. F. Bates, College of Mineral Industries, Pennsylvania State University, University Park, Pa.

Announcements

PROF. RENÉ FABRE, professor of toxicology and dean of the Faculty of Pharmacy, University of Paris, has been elected a member of the Rural Economy Section of the Paris Academy of Sciences in succession to the late A. Demolon.

PROF. F. V. ATKINSON, professor of mathematics in University College, Ibadan, has been appointed professor of mathematics in Canberra University College.

PROF. A. P. GUINAUD, associate professor of mathematics in the Royal Military College of Science, Shrivenham, has been appointed professor of mathematics in the University of New England, Armidale, New South Wales.

THE Istituto Lombardo di Scienze e Lettere is arranging to hold the first Antonio Baselli Conference at Pellanza during July 28-30. The subject will be "The Macromolecules of the Organism". Those wishing to attend should write to the Secretary of the Istituto Lombardo, via Brera 28, Milan, from whom further information can be obtained.

THE Northern Division of the Institution of Electronics will be holding its tenth annual electronics exhibition in the College of Technology, Manchester, during July 14-20. More than fifty organizations will be exhibiting, divided between a scientific and industrial research section (composed of displays from the research associations and laboratories, government establishments, universities, hospitals, etc.) and a manufacturer's section. Forty lectures and sixteen film shows will be given. Admission tickets both to the lectures and the exhibition, together with any further information, can be obtained from the honorary organizing secretary of the exhibition, W. Birtwistle, 78 Shaw Road, Thornham, Rochdale, Lancs.

THE United Kingdom Papers Committee has completed its official list of those attending the International Conference at Geneva during August on the Peaceful Uses of Atomic Energy. It is still possible, however, for any further interested persons to apply for seats in the public gallery. Applications should be made direct to Dr. Adrian Pelt, Director, European Office of the United Nations, Palais des Nations, Geneva.

NEW PHYSICS LABORATORIES AT UNIVERSITY COLLEGE, LONDON

THE new Physics Wing at University College, London, was officially opened on May 4 by Sir James Chadwick, in the presence of some five hundred guests widely representative of the scientific, industrial and teaching life of the community.

The opening of this new building marks the completion of the first stage in the provision of permanent accommodation for the Physics Department after the destruction suffered during the Second World War. It provides something less than half the floor space which, it is envisaged, will eventually be made available to the Department.

The building, which has six floors, was designed by Prof. A. E. Richardson and built by Messrs. Dove Bros., Ltd. It is of steel frame construction faced mainly with Kentish stock brickwork, but has Portland stone up to the ground-floor level and stone dressings around the windows. The roof is of concrete, insulated with cork and covered with copper. In order to save the cost of periodical repairs, the window sashes are constructed of aluminium, specially treated to resist corrosion. Invisible steam pipes embedded in the ceilings provide heat for the building. Three rows of steel channel inserts fixed flush to the surface of all available wall space provide ready means for suspension and temporary fitting of apparatus.

Three of the six floors are devoted mainly to research, and the remaining three floors to teaching laboratories. These undergraduate laboratories, situated on the first, second and third floors, can accommodate all the undergraduate practical training, except for an elementary class still housed in an older part of the College. Accommodation is provided for about thirty-five students in each of the three years of the course for the B.Sc. (Special) degree in physics as well as for a somewhat larger number of students who take a two-year course in physics ancillary to chemistry or astronomy. A number of students reading physics for the B.Sc. (General) degree are also accommodated.

Each of the undergraduate laboratories occupies a floor space of 4,600 sq. ft. and includes dark rooms for optical experiments, extensive apparatus stores and technicians' rooms. In addition, there are fully equipped photographic dark rooms, a balance room, and workshop facilities for the use of undergraduate students. There are some sixty or seventy student benches in each laboratory, and points for gas, water and electrical power are liberally distributed.

Particular care has been taken with the design of facilities for the third-year student laboratory. It has been the custom at University College for several years now to encourage third-year undergraduate students of experimental physics to develop their originality by tackling more elaborate experiments than they have attempted previously. They are given small experimental projects in which they gain experience in the design and construction of apparatus and in solving problems relating to its working. While these experiments cover a wide range of topics, considerable emphasis is placed on electronics.

It is interesting to recall that the first courses in practical physics arranged for undergraduate students in any English university were given at University

College in the session 1866-67 on the initiative of Prof. Carey Foster. The new teaching laboratories should provide adequate facilities to enable the traditions of the College in the teaching of practical physics to be worthily maintained.

Turning now to the research facilities provided by the new building, these are housed on the lower ground floor, the ground floor and the fourth floor.

The lower ground floor has a ceiling 16 ft. 6 in. high, and the greater part of the floor is occupied by the electron accelerator laboratory, which extends along the whole length of the floor and over about two-thirds of the width. An overhead travelling crane runs the full length of this laboratory, which is at present divided into three rooms by temporary partitions.

A microtron (electron cyclotron) accelerator producing a mean extracted current of 0.5 μ amp. of electrons at 5 MeV. energy has been constructed and is in full operation. A larger microtron to provide 25-MeV. electrons is under construction and will also be installed on the lower ground floor. Both these machines are to be used in an extensive study (already in progress) of fast-electron scattering by nuclei.

The lower ground floor also houses a store, glass-blowing shop, dark rooms, a spectroscopic laboratory, and a room for storing and handling small quantities of radioactive isotopes.

The ground floor contains a number of private staff rooms and offices; but research laboratories comprise the greater part of this floor also. Most of the research in progress on this floor is devoted to the experimental study of electronic and ionic collisions. Systematic investigations are in progress on the exchange of charge or excitation, on ionization, and on elastic scattering produced when beams of ions or metastable atoms are passed through gases. Extensive work is also concerned with collision processes in atomic hydrogen and with studies of gaseous discharges. Gas, water, compressed air and oxygen services are installed throughout the ground and lower ground floors, as well as an adequate supply of d.c. and a.c. (both single- and three-phase) points.

The top floor, in addition to providing office accommodation for members of the staff and for research students specializing in theoretical physics, houses the departmental library, a small lecture room used particularly for seminars, and the computing laboratory. An electronic computer designed by Dr. A. D. Booth, of Birkbeck College, is now being installed in the computing laboratory. In addition to providing for the needs of the theoretical research in the Department, it is intended that when fully in operation the facilities of this machine will be made available to other departments of the College and University.

The number of research workers in the Physics Department at University College is large. There are some fifty postgraduate Ph.D. students, while there are altogether 78 research workers in the Department. Only some of these are accommodated in the new wing, however. The research groups working on the high-pressure cloud chamber, high-energy nucleon scattering and the electron lens

for electron and positron scattering are still housed in temporary quarters. It is hoped that eventually all the rest of the research work of the Department as well as the workshop and lecture theatres will be accommodated in an adjacent building under conditions as satisfactory as those of the new wing.

THE PHARMACEUTICAL SOCIETY

ON May 23, the Pharmaceutical Society of Great Britain held a reception to mark the granting of its new constitution. Founded in 1841, the Society received a Royal Charter in 1843. Modifications were afterwards made in its constitution by the various Pharmacy Acts. A Supplemental Charter granted in 1953, virtually replacing the original, and the Pharmacy Act 1953 have now brought the Society's constitution into line with present-day circumstances and needs. A reception was held at 66 Portland Place, W.1, through the kindness of the Royal Institute of British Architects, to mark the occasion, and H.R.H. the Duke of Edinburgh attended the reception and was presented during the evening with his diploma as the first Honorary Fellow of the Society.

The Society's charters and grant of arms were on view, together with rare books from the Society's Library. *Incunabula* were represented by the "Latin Herbarius" printed at Passau in 1485, and the 1491 edition of the "(H)ortus Sanitatis" from the press of Jacob Meydenbach at Mainz. The latter, a treatise on herbs, animals, birds, fishes, stones and minerals, showed the illustration of the Bausor tree, believed to exhale a narcotic poison. In the illustration two men lie beneath its branches, apparently in the sleep of death. Manuscripts included an early recipe book in Elizabethan hand and a fine English medical work of the seventeenth century, bound in contemporary calf. A copy of the second issue of the first "London Pharmacopoeia" of 1618 published in December of that year attracted much interest. The first issue was published in May, but it was so full of errors that all copies were officially destroyed; a facsimile of it was exhibited. The first quarto edition, published in 1699, of the well-known satirical poem "The Dispensary", by Dr. Samuel Garth, dealing with the quarrels between the Society of Apothecaries and the Royal College of Physicians, was also on view.

At the request of the Duke of Edinburgh, an exhibition had been staged to portray the pharmaceutical industry's contribution to medical and veterinary science.

Featured on twenty large panels, arranged by the Association of the British Pharmaceutical Industry, was a representative selection of the drugs discovered and developed in recent years, which have revolutionized the practice of medicine and have made a significant contribution to advances in surgery.

In an introductory panel, some statistics of the industry were shown graphically. Its production, valued at £19 million in 1935, had risen to £120 million in 1954. The numbers of persons employed by the industry in research, development, manufacture both primary and secondary, and in distribution to the pharmacist, doctor and hospital, had risen much less than proportionately—from 22,000 in 1935 to 53,000 in 1951. Its exports, valued at £3.28 million in 1938, amounted in value to £33.6 million in 1954.

The tendency to think of modern medicine in terms of sulphonamides, antibiotics and other recently discovered life-saving drugs often leads to the supposition that symptomatic treatment no longer has a place in medicine. As a reminder that preparations of vegetable drugs and their active principles are still used in considerable though steadily diminishing amounts, a panel was included featuring a flow chart of the manufacture of a galenical, photographs of fields of henbane, foxglove (*digitalis*) and deadly nightshade (*belladonna*), together with specimens of an opium poppy capsule, gentian root, *nux vomica* seeds, ergot sclerotia, and preparations of *digitalis*. Roots of *Ranunculus serpentina* and its principal alkaloid reserpine, now much used for mild hypertension and psychotic disorders, were also shown. The commercial development of the synthesis of atropine and the tropane alkaloids was illustrated by a photograph of the British plant now used for this purpose.

The developments in anaesthesia since Sir James Young Simpson introduced the use of chloroform in Edinburgh in 1847 were exemplified by the newer anaesthetics such as cyclopropane, trichloroethylene (including its application by self-administration) and thiopentone (used intravenously).

Muscle relaxants, which have a temporarily paralysing action and greatly facilitate modern surgery by avoiding the need for almost toxic doses of anaesthetic, derive their application from the isolation of the alkaloid tubocurarine from the South American arrow poison, curare. Poison-tipped darts and blowpipe, crystalline curare and a curare gourd prefaced specimens of tubocurarine and the more recently developed synthetic analogues, gallamine triethiodide and laudexium methylsulphate.

The development of specialized contrast media by the British pharmaceutical industry has enabled the medical use of X-rays to be extended, and in addition to the detection of bone fractures they now aid the radiologist to give a prominent picture of the gall-bladder, arteries, bronchial tree, the urinary tract and other systems and organs. Among the radiological agents displayed were barium sulphate for preparation of barium meals, diiodone, iodized oil, propyl iodone, iodoxyl and ethyl iodophenylundecylate.

The use of injectable fluids to restore blood volume in cases of patients suffering from shock and loss of blood, as an alternative to the transfusion of blood, began with the discovery of the value of gum acacia-saline injection during the First World War. Dextran and polyvinylpyrrolidone were exhibited as newer agents which avoid the adverse effects of acacia-saline on the blood and liver. They are polymers of sufficiently high molecular weight not to be excreted too quickly.

The antibiotics formed the subject of two panels and exhibits. A photograph of the late Sir Alexander Fleming fittingly introduced the panels, which included a flow chart of penicillin manufacture, a chart depicting the rate of growth of manufacture and export of penicillin and its preparations, and another showing the estimation of sensitivity of organisms to antibiotics. Specimens shown of the different forms of presentation of penicillin included vials of penicillin G for preparation of the injection, of procaine penicillin, of oral suspension, tablets and ointment, and of penethamate hydriodide and benethamine penicillin. Specimens were also shown of streptomycin sulphate, chloramphenicol capsules, aureomycin, oxytetracycline, tyrothricin lozenges, polymixin-bacitracin ointment, neomycin, viomycin,

and erythromycin. The application of antibiotics as supplements in animal feeding to increase the rate of growth of animals was illustrated by photographs of piglets at different ages after so feeding.

Antihistamines exhibited included diphenhydramine, mepyramine, promethazine, antazoline, chlorcyclizine and phenindamine, together with a diagram of the action of antihistamines and a reminder of their value in preventing travel sickness and nausea and vomiting due to other causes. It was only in 1910 that Sir Henry Dale, then working in the research laboratories of a British pharmaceutical company, had fully investigated histamine, a natural constituent of the living tissues, and the liberation of which is largely responsible for allergic manifestations. It was only subsequent to 1910 that the search for histamine antagonists began. For some years the main histamine antagonist was adrenaline. More recently a homologue, isoprenaline, has been much used as its sulphate. What are now called 'antihistamines' have the more specific action of neutralizing directly the physiological effects of histamine.

Anticoagulants which have revolutionized the treatment of thrombo-embolic disease interfere with the process of coagulation of the blood, a process illustrated by a chart. The exhibits included the naturally occurring heparin, extracted from lung or liver tissue, the synthetic anticoagulants, dicoumarol and its derivatives, phenylindanedione, as well as dextran sulphate discovered by Ricketts and Walton at Birmingham.

The importance of antimalarials was illustrated by a map showing the world incidence of malaria, and a chart illustrating the life-cycle of the malaria parasite and photographs showing methods of eradication of mosquitoes. Antimalarials exhibited included quinine both as tablets and injection, amodiaquine, pyrimethamine, chloroquine, primaquine and proguanil.

Some of the problems of tropical medicine were illustrated by photographs of patients suffering from elephantiasis, leprosy, bilharzia and trypanosomiasis, and by a table showing the carriers of and parasites responsible for these diseases and the modern methods used for their treatment. A tank of snails served as a reminder of the problems of eradication of bilharzia from endemic areas. Specimens of medicaments shown included the anti-leprotic sulphones, tryparsamide, lucanthone, sodium stibogluconate, diethyl-carbamazine, suramin, pentamidine isethionate and yellow-fever vaccine.

A panel devoted to veterinary medicine emphasized the application of the newer human remedies to the treatment of animal diseases, as well as the development of specific serological products. Limitations of space scarcely permitted justice to be done to the contributions of the industry to the advances in animal medicine.

A portrait of Lord Lister introduced recent developments in antiseptics, which were exemplified by specimens of aridine derivatives, halogenated phenols such as chloroxylenol, *p*-chloro-*m*-xylenol and cresol, and the quaternary ammonium compounds cetrinide, benzalkonium and domiphen bromide.

The progress of the British development of insulin manufacture since Banting and Best's discovery of insulin in 1922 was dramatically illustrated by a chart of the price reductions that have followed its increasingly large-scale production to meet the demands of diabetics throughout the world. Charts showed the duration of reduction of blood sugar by soluble insulin and its complexes with globin and

protamine in the presence of zinc and of the more recently developed insulin zinc suspensions.

Other hormones and their derivatives exhibited included testosterone, methyl testosterone, oestrone, ethinyl-oestradiol, stilboestrol and cortisone, acetate (manufactured in Britain from hecogenin isolated from sisal). Supporting charts showed the chemical inter-relationships of the medicinally used steroids and the influence of hormones in the menstrual cycle.

Immunological products were introduced by a portrait of Jenner, a chart showing the changed incidence of diphtheria in recent years and photographs of sera manufacture, the preparation of B.C.G. vaccine and inoculation of culture media. In addition to specimens of different sera and vaccines, there were shown publicly for the first time specimens of the Salk antipoliomyelitis vaccine manufactured by a British firm.

Specimens of an almost complete range of the vitamins used medicinally, including about a gram of crystalline cyanocobalamin (vitamin B₁₂), supported illustrations of vitamin-deficiency states and of plant employed in the manufacture of certain vitamins by synthetic methods.

Following Domag's discovery of the value of prontosil in chemotherapy, and of Fournieu's recognition that the sulphanilamide fragment was wholly responsible for its action, the synthesis and evaluation of sulphapyridine by a British firm set the pattern for the highly effective sulphonamides now used in chemotherapy. Despite the introduction of antibiotics, the sulphonamides are still widely used in the treatment of many diseases and have aided in the avoidance of, and in dealing with, drug-resistant strains of organisms. A photograph of Dr. A. J. Elwyn introduced a panel depicting various aspects of sulphonamide evaluation and therapy, and specimens of sulphonamides displayed included sulphadiazine, sulphadimidine, sulphafurazole, sulphamerazine, sulphathiazole, phthalyl- and succinyl-sulphathiazoles, sulphaguanidine, sulphasomidine and sulphacetamide both in powder form and in tablets.

The assistance given by analgesics and hypnotics in coping with the exigencies of modern civilization have led to the search for, discovery and manufacture of, the wide range of barbiturates, specimens of short-, medium- and long-acting ones being shown. Although substantial quantities of morphine are still manufactured and used, synthetic analogues such as pethidine, of which a specimen was shown, are steadily replacing morphine in many of its applications.

The skills of the organic chemist, the pharmacologist, the biochemist, the bacteriologist, the microbiologist and the chemical engineer are of little avail to modern medicine unless the products emerging from their work are presented in stable, effective and acceptable form for use by the patient or medical practitioner. It is to the formulation, preparation and directions for use of the whole range of medicaments that the pharmacist applies his training and knowledge. It was therefore fitting that the final exhibit should be devoted to specimens of the forms in which medicaments are used: tablets, pills, capsules, ampoules and multiple-dose injection containers, suppositories, bougies, pessaries, cachets, lozenges, pastilles, creams, ointments, dusting powders, mixtures, syrups, mouth washes, paints, liniments, lotions and eye drops.

CONDENSATION NUCLEI

SYMPOSIUM IN DUBLIN

A SYMPOSIUM on condensation nuclei was held in the School of Cosmic Physics, Dublin Institute for Advanced Studies, during April 26-28, when thirty-four delegates from eight countries participated and twenty-six papers were presented. The five half-day sessions dealt with the meteorology, climatology and aerology of nuclei, new instruments and methods for recording their concentration, measuring their size, density and mass, their biological role and importance for research in hygiene and the production of nuclei under special conditions.

The relationship between the concentration of atmospheric nuclei measured with a photo-electric counter twice daily over a four-year period at Valentia Observatory and meteorological elements has been investigated by S. McWilliams and W. A. Morgan (Ireland). The majority of observations gave a count of less than 500 nuclei cm^{-3} ; the concentration generally decreased with increasing relative humidity and the annual variation followed fairly closely that of duration of bright sunshine.

M. Bider (Switzerland) presented a similar investigation for Basle based on continuous records obtained by means of the automatic Verzár photo-electric nucleus counter. Since this recorder measures concentration every fifteen minutes, many problems can be tackled which with eye observations at a few fixed hours could not be approached. The increase of concentration with sunshine established near the Atlantic at Valentia was also found at Basle. Simultaneous records with identical Verzár automats in the centre of the city and on the outskirts at a distance of 1.5 km. have shown that the average concentration in the centre (46,000 nuclei cm^{-3}) is about eight times that on the outskirts. In spite of this very large difference in the concentrations, the variation at both stations was strikingly similar.

G. J. Day (Meteorological Research Flight, Farnborough) delivered a preliminary report on measurements of condensation nuclei made with a direct-beam photo-electric counter during ten aeroplane ascents over the British Isles in mainly anticyclonic situations. He found that clean maritime air passing over unbroken sea surfaces contains about 200 cm^{-3} nuclei at normal cloud-base levels (approximately 2,000 ft.), though it often contains as many as 3,000 cm^{-3} nuclei in the lowest few hundred feet. Over broken sea surfaces values of 1,000 cm^{-3} nuclei are found throughout the turbulent mixing layer, so that it appears that sea salt nuclei contribute a large, though not a major, part to the nucleus population. At heights of 1,000-2,000 ft., during flights covering most of England, and including some circumnavigations of Greater London, a normal concentration of about 2,000 cm^{-3} nuclei was found which rose to 5,000 cm^{-3} nuclei over large domestic and industrial centres. Contrary to expectation, no increase in the general level of concentration downwind of large contaminating centres such as London was found. However, downwind of specific sources within such areas, concentrations of tens of thousands of nuclei per cm^3 , often thirty thousand, were observed. These localized increases seem associated with a relatively few sources and must presumably be associated with specific industrial processes.

Mrs. Rita Callahan Sagalyn (United States Air Force Cambridge Research Center) reported on concentration, mobility and distribution of charged nuclei in fair weather and in the altitude-range 500-20,000 ft. These investigations over the United States and the Atlantic Ocean were carried out together with G. Faucher in a B-17 aeroplane converted into a veritable flying observatory. A series of diurnal measurements made over a fixed flight-path indicates the importance of turbulence and air-mass changes for the distribution of nuclei in the atmosphere.

New ingenious methods for counting nuclei, which J. C. Thams and W. Wieland (Locarno-Monti) have recently developed, were described and illustrated by Dr. Bider. The droplets formed by expansion in an Aitken-Scholz counter, and even the nuclei themselves before forming cores of droplets, are caught on slides coated with a thin (0.01 mm.) layer of copal-lacquer in which they produce holes. The counting of the holes is rapidly carried out by a photo-electric device.

Great progress in recording nuclei concentration is noticeable in the second version of the automats designed by F. Verzár (Basle) and the construction by R. Sikana (Uppsala). Both elaborate automats employ the direct-beam photo-electric principle, and the latter in addition uses continuous photographic recording of the droplets in an Aitken-type counter. R. Mühleisen's (Western Germany) new recorder for nuclei concentration with continuous over-saturation, which hitherto had escaped general notice, has the advantage of recording concentration in one-minute intervals.

Recently in meteorology there has been a tendency to seek information on the size of the condensation nuclei and their nature as well as their concentration. A variation of the photo-electric nucleus counter to obtain size discrimination was demonstrated by T. A. Rich (General Electric Company, United States). The sample at atmospheric pressure in the fog-tube of the counter is expanded into two evacuated containers: into one as rapidly as possible, into the other slowly enough to permit the growth of water drops and yet fast enough so that the expansion is essentially adiabatic.

Preliminary tests of a new method for measuring the size, density and mass of condensation nuclei which L. W. Pollak and T. C. O'Connor (School of Cosmic Physics, Dublin) have designed for investigating the quickly changing atmospheric aerosol, particularly during aeroplane flights, are encouraging. The underlying theory of this 'static' method was developed by R. Fürth (Birkbeck College, University of London). Utilizing standard equipment and measuring the decreasing concentration of condensation nuclei when enclosed in a small cylindrical container, it is possible to determine from two measurements of concentration the size of the nuclei and from three such measurements their size, density and mass.

P. J. Nolan and E. Kuffel (University College, Dublin) dealt with the decay of enclosed nuclei. They found with ultra-small nuclei that the coefficient of the linear diffusion term in the decay equation varies as the square root of the diffusion coefficient. The production of nuclei from ammonia and nitric acid were discussed by P. J. Nolan and E. Kuffel; that of uncharged nuclei by ultra-violet light formed the subject of a most interesting paper by J. R. Atkinson (Glasgow), whose results are also of importance for users of cloud chambers.

The retention of condensation nuclei in the respiratory tract was dealt with by F. Verzár and P. J. Nolan. Based on experiments made by T. Burke and himself, Nolan stated that nuclei are not produced by breathing. Exhaled air contains 80–20 per cent of the nucleus content of the inhaled air. Mr. Claes Rooth summarized most ably the important work by C.-G. Rosaby (Stockholm) and H. Egnér (Uppsala) on the synoptic variations in the chemical composition of atmospheric precipitation and made a strong plea for introducing measurements of carbon dioxide as a routine in meteorological networks.

In the geophysical laboratory of the School of Cosmic Physics, Dublin, equipment for determining concentration and size of condensation nuclei and for measuring their vertical gradient near the ground were demonstrated during the symposium. A small exhibition showed the development of the photo-electric nucleus counter. Among the exhibits were a photograph of the direct-beam photo-electric nucleus counter, and the original model of the multiflex photo-electric counter which L. W. Pollak designed and W. A. Morgan constructed in the offices of the Irish Meteorological Service at Foynes early in 1940. The proceedings of the symposium will be published as a separate volume of *Geofisica Pura e Applicata* (Milan). The next symposium on condensation nuclei is to take place in September 1956 in Switzerland.

L. W. POLLAK

TAPEWORMS OF THE FAMILY TETRABOTHRIIDAE

AN interesting and important paper by Prof. J. G. Baer has been published as a memoir of the University of Neuchâtel* on a taxonomic revision and biological study of the Cestodes of the family Tetrabothriidae parasitic in birds of the high seas and marine mammals. In the paper, Prof. Baer aims at classifying and simplifying the determination of this very difficult group of tapeworms, and seeks to show—with considerable success—that a parasite and its host are fundamentally inseparable. The two must be considered together.

The revision is based on the re-examination of more than seventy types of the eighty-odd species described, with the result that the number of species is reduced to forty, and only four of the eleven genera are retained. The monograph is divided into five sections, the first three of which are entirely given up to the descriptions of the species together with their synonyms, hosts and the more important bibliographical references. An introductory chapter deals with the general anatomy, and it is found that neither the size of the scolex nor the muscular development of the strobila are reliable taxonomic characters, as was formerly supposed to be the case. On the other hand, the structure of the genital atrium is stressed since it appears to yield by far the best and most reliable morphological character. This structure, however, can only be seen in transverse sections, and therefore no specific identification is possible if worms are mounted *in toto*. All the species

are described in a uniform manner, and only the essential characters are stressed. The genital atrium of each species is illustrated, and all the drawings made to the same scale, so that comparisons are easily made, while a special section is devoted to the comparative anatomy of the species. It is found that the structure of the genital atrium reveals the existence of three distinct evolutionary trends, making it possible to split the species into distinct groups. A key for the identification of the species is thus established. The position of the family Tetrabothriidae is discussed and it is assigned to a new order, distinct from either the Pseudophyllidae or the Cyclophyllidae but more closely related to the Tetraphyllidae.

Tetrabothriids are found to be extremely host-specific; each group of hosts—namely, Sphenisciformes, Procellariiformes, Pelecaniformes, Gaviiformes and Charadriiformes—harbours species distinct from those occurring in the others. Although the life-cycle of the tapeworms is unknown, it is postulated, on the basis of stomach contents of the sea-birds and mammals, that cephalopods might act as intermediate hosts. From statistical evidence it seems that the host can only become infested when leading a semi-sedentary life, that is, during the breeding season. This is also borne out by the fact that different hosts belonging to the same order nesting on the same island usually harbour the same species of tapeworm. Using the evolutionary trends of the genital atrium as a basis, combined with the results obtained from a statistical study of the distribution of the parasites among the hosts, it is found that there is distinct evidence of parallel evolution of both the tapeworms and their hosts. From these results it is postulated that the Sphenisciformes, Procellariiformes and Elecaniformes might be derived from a common stock, and the Gaviiformes and the Alcae appeared later as side branches. The arguments and evidence put forward here by Prof. Baer are convincing, and one feels that his main conclusions are right. He also suggests that the species harboured by gulls have been acquired secondarily. But here he is not quite so confident; the case is certainly more open to argument, and one wonders if perhaps only one of the gull lines has been acquired thus.

I think, however that Prof. Baer rather over-emphasizes (p. 104) the apparent contradiction in the conclusions he reaches from the study of Tetrabothriids and the evidence deduced from a study of the Mallophaga. True, his conclusions are not entirely confirmed by the published work on the feather lice, but this is largely owing to the fact that evidence from the distribution of the Mallophaga is rarely helpful in the elucidation of the relationship between orders of birds. Thus the Mallophaga of the Sphenisciformes and Gaviiformes show no apparent relationship to those of other birds. While, although some of the Mallophaga of the Procellariiformes, Pelecaniformes and Charadriiformes do not rule out a possible relationship between these orders, the evidence is in no way conclusive.

Finally, it must always be remembered that the classification of the birds themselves is in some cases still open to doubt, and the characters upon which families are assigned to certain orders may be less dependable than the characters chosen for classifying their parasites. Unfortunately, specialists are not often in a position to evaluate the classification of groups other than their own, and are chary of taking

* Révision taxonomique et étude biologique des Cestodes de la famille des Tetrabothriidae parasites d'oiseaux de haute mer et de mammifères marins. By Jean G. Baer. Mémoires de l'Université de Neuchâtel, Série in-quarto, 1, 1954. Pp. 123 + 82 figs. (Neuchâtel, 1954.) 20 Swiss francs.

so much on trust. If Prof. Baer has discovered in the genital atrium a character which is dependable—a point which time alone will prove to everyone's satisfaction—it is a matter of great importance from the point of view of elucidating host/parasite relationships.

One minor point is worth noting: a fine trap is set for the English-speaking reader by the use here and there of vernacular names of the hosts. Thus, "Pingouin" equals razorbill, not penguin, and "Puffins" are shearwaters, not puffins in our sense.

MIRIAM ROTHSCHILD

RADIO EMISSION FROM JUPITER

THE Carnegie Institution of Washington announced in April that radio emissions from Jupiter had been detected on a frequency of 22 Mc./s. The receiving system consisted of a large cross aerial, of the type developed by Mills in Sydney for radio astronomy, which produces a narrow beam in a fixed direction. The Carnegie aerial occupies a 96-acre field near Seneca, Maryland, and although the beam-width is not stated it may be deduced to be of the order of one degree from the fact that Jupiter passes through the aerial beam in six minutes. The radio emissions were reported to have the appearance of short random bursts of static resembling thunderstorm interference on a broadcast receiver and were observed about one day out of three during the time when Jupiter was in the beam of the aerial system. The location of the sky from which these bursts originated agreed with the position of Jupiter over a period of several months, and hence it can be presumed that any terrestrial origin of the bursts has thereby been excluded.

The study of radio waves from the sun is a well-known and important part of radio astronomy. The signals are relatively intense; those from the quiet or undisturbed sun originate in the corona, which has an equivalent black-body temperature of the order of a million degrees at these low frequencies. Success has also been achieved in measuring the radio emission from the moon by Dicke and Beringer in 1946, and by Piddington and Minnett in 1949. In this case the emission measured, on a wave-length of 1.25 cm., corresponds to the black-body radiation appropriate to a lunar surface temperature of 250° K. The surface temperature of Jupiter measured at the top of the cloud layer is about 160° K., and hence the signal bursts received by the Carnegie workers on 22 Mc./s. must have quite a different origin from the solar or lunar emissions.

It has been suggested that the Jupiter signals are caused by disturbances in the planetary atmosphere similar to terrestrial thunderstorms, but on a much larger scale. It is possible to estimate the likelihood of this from the radiation field produced by a single lightning flash in the earth's atmosphere which, according to the measurements of E. T. Pierce, is 15 V./m. at a distance of 20 km. On a frequency of 1 Mc./s. and band-width 1 Mc./s. At the distance of Jupiter the field-strength would be 5×10^{-7} V./m. and the power flux about 10^{-21} W. m.⁻² (c./s.)⁻¹ at 1 Mc./s. Making reasonable assumptions about the frequency spectrum and remembering that in the terrestrial atmosphere the rate of occurrence is about

a hundred flashes per second, it seems that the thunderstorm static from the earth at the distance of Jupiter would amount to about 5×10^{-21} W. m.⁻² (c./s.)⁻¹, which would be readily detectable by contemporary techniques such as that used by the Carnegie workers. However, this signal would appear as a steady background, whereas the Jupiter signals occurred on only one day in three and were apparently in the form of bursts. It seems clear that the further development of this work may well provide new and valuable information about the conditions in the atmosphere of Jupiter.

ABNORMAL PROTEIN ASSOCIATED WITH TOBACCO MOSAIC VIRUS

Structure of Polymerized Tobacco Plant Protein and Tobacco Mosaic Virus

WHEN tobacco plants are infected with tobacco mosaic virus, an abnormal protein can be isolated from the tobacco leaves¹. It has been demonstrated that this protein is non-infectious, is free of ribonucleic acid, and is immunologically related to the protein component of the virus². In addition, this protein has the peculiar property of polymerizing into rod-like structures when brought close to its isoelectric point at pH 3.8. In the electron microscope, these rods appear to be similar to tobacco mosaic virus rods, except that their length is more variable than that of freshly harvested tobacco mosaic virus.

There has been some debate concerning the exact nature of these nucleic acid-free rods, which appear so similar to tobacco mosaic virus^{2,3}. A recent amino-acid analysis has shown that the composition of the abnormal protein is virtually identical to that of the protein component of the virus⁴. Here we wish to present X-ray diffraction evidence which demonstrates that the internal structure of the nucleic acid-free particles is similar to that of the virus.

Samples of the abnormal protein from tobacco plants were prepared by methods which have been described previously³. Freedom from contamination with tobacco mosaic virus was assured by the following tests: (a) When the abnormal protein is prepared in unpolymerized form at pH 7, there is no high-molecular weight component observable in the ultracentrifuge, and no evidence of a rapidly migrating component in electrophoresis. (b) The ultra-violet absorption spectrum is that of a protein free of nucleic acid, with the ratio of optical densities at 280 mμ and 260 mμ of 1.6–1.7; for tobacco mosaic virus this ratio is 0.83. (c) Electron micrographs of unpolymerized abnormal protein show no tobacco mosaic virus-like rods. (d) The material is not infectious. In summary, the contamination of abnormal protein by tobacco mosaic virus, if any, should be considerably less than 1 per cent.

The abnormal protein was gradually brought to its isoelectric point, and typical rod-like forms were observed in the electron microscope. Oriented air-dried films of this material and of tobacco mosaic virus grown on the same tobacco plants were prepared by the microscope slide technique of Bernal

and Fankuchen⁵. The observed birefringence of the films was + 0.003, as reported previously for tobacco mosaic virus, and - 0.002 for the abnormal protein. X-ray diffraction photographs were taken with copper K α radiation in a 10-cm. cylindrical camera filled with helium.

Tobacco mosaic virus has been extensively studied by X-ray diffraction methods. Bernal and Fankuchen⁵ have shown that the rods are arranged in hexagonal close packing, with interparticle distances which can be varied with the amount of water present. Only the equatorial reflexions arise from the hexagonal lattice. The non-equatorial scattering is relatively unaffected by changes in water content. It represents the continuous transform of a single particle and, as such, is characteristic of the internal structure of the virus. Watson⁶ has proposed a helical arrangement of the protein sub-units in the virus particle. A recent paper by Franklin⁷ has demonstrated with remarkable detail the finer features of the tobacco mosaic virus diffraction pattern.

Although the orientation of the abnormal protein in the air-dried films was not as complete as in the films of tobacco mosaic virus, the general similarity of the two diffraction patterns is very obvious. The 3rd and 6th layer lines are very intense and close to the meridian, the 9th is weaker; the 2nd and 7th layer lines show strong off-meridional reflexions. All these features are characteristic of the tobacco mosaic virus diffraction pattern and establish the gross similarity of the structures.

Measurements on the equator of the photographs of the abnormal protein are obscured by poor orientation and are not reliable. However, it is apparent from our photographs that significant differences in the diffraction pattern occur in this region. Table 1 lists the spacings observed, together with their intensities and hexagonal indices. Bernal and Fankuchen⁵ have pointed out that the intensities are very sensitive to water content. In these experiments, both samples were treated identically. The correspondences between the patterns indicate that the hexagonal arrangement of the tobacco mosaic virus rods is retained in the abnormal proteins with little change in spacing, possibly a slight increase. The most striking difference is the absence of the strong 50-A. reflexion in the abnormal protein photographs.

Table 1. COMPARISON OF EQUATORIAL REFLEXIONS

$h^2 + k^2 + hk$	Tobacco mosaic virus d (Å.) observed	Abnormal protein d (Å.) observed
1	(not observable in this apparatus)	
3	74 (vvs)	77 (vvs)
4	—	(67 (vvw) ?)
7	50 (vs)	—
12 (13)	36 (m)	37 (m)

Intensities. vvs = very, very strong; vs = very strong; m = medium; vvw = very, very weak.

The equatorial scattering from tobacco mosaic virus has already been shown to follow approximately that expected from an array of cylindrical rods of diameter about 150 Å. and of uniform scattering density⁸. We do not believe that the equatorial scattering of the abnormal protein can be adequately interpreted in this way. We can, however, account for it as follows.

We regard the abnormal protein not as a uniform structureless rod, but rather as a cylindrical shell of protein surrounding an empty (water-filled) core. The Fourier transform of such a shell is the difference of two first-order Bessel functions:

$$T(h) = R^2 \frac{J_1(2\pi h R)}{2\pi h R} - r^2 \frac{J_1(2\pi h r)}{2\pi h r}$$

where R is the external radius, r is the internal radius corresponding roughly to the radius of the ribonucleic acid core of tobacco mosaic virus, and h is distance in reciprocal space. If R is taken as 76 Å., the protein shell being supposed identical with that of tobacco mosaic virus, the transform becomes zero at 50 Å.⁻¹ for $r = 19.5$ Å. This radius for a ribonucleic acid core corresponds to a value of 6.6 per cent ribonucleic acid in tobacco mosaic virus, assuming, as we have above, that cross-sectional area is proportional to mass. The experimentally observed value is near 6 per cent⁸. The calculated percentage is, of course, sensitive to the assumed diameter of the protein rod.

A central location for viral nucleic acids has been discussed previously. Watson⁶ has considered such a model for tobacco mosaic virus itself. The deoxy-ribonucleic acid in the bacteriophage virus T_2 is believed to be located inside the virus⁹. A similar interpretation has been given for turnip yellow virus. The low-angle X-ray studies of Schmidt, Kaesberg and Beeman¹⁰ indicate that the ribonucleic acid-free virus particles have an inner sphere of low density, a region in which they believe the ribonucleic acid is replaced by water.

Careful measurements of the c-axis spacing produced by the abnormal protein showed a shortening of 5 per cent less than the usual value of 68 Å., or about 3.5 Å. shorter. One possibility is that the absence of the ribonucleic acid permits the protein units to pack more tightly, perhaps eliminating one layer of water molecules. In this regard, Franklin⁷ points out that there is an important structural discontinuity between the various turns of the helix, possibly associated with an external grooving. It may be that this groove is partially eliminated in the absence of the ribonucleic acid.

In summary, these studies have pointed out the essential similarity between the configuration of the polymerized abnormal protein of the infected tobacco plant and the virus itself. Small differences are observed in the diffraction patterns, which suggest that it may be possible to determine accurately the position of the ribonucleic acid in the virus.

ALEXANDER RICH
J. D. DUNTZ

Laboratory of Neurochemistry,
National Institute of Mental Health,
Bethesda, Maryland.

P. NEWMARK

Department of Biochemistry,
University of Kansas,
Lawrence, Kansas.

Feb. 24.

¹ Takahashi, W. N., and Ishii, M., *Nature*, **169**, 419 (1952). Commoner, B., Newmark, P., and Rodenberg, S., *Arch. Biochem. and Biophys.*, **37**, 15 (1952). Jeener, R., and Lemoine, P., *Nature*, **171**, 985 (1953).

² Wang, T., and Commoner, B., *Science*, **120**, 1001 (1954). Jeener, R., Lemoine, P., and Lavend'homme, C., *Biochim. Biophys. Acta*, **14**, 321 (1954).

³ Delwiche, C. C., Newmark, P., Takahashi, W. N., and Ng, M. J., *Biochim. Biophys. Acta*, **16**, 127 (1955).

⁴ Newmark, P., and Fraser, D., *J. Amer. Chem. Soc.* (in the press).

⁵ Bernal, J. D., and Fankuchen, I., *J. Gen. Physiol.*, **25**, 111, 147 (1941).

⁶ Watson, J. D., *Biochim. Biophys. Acta*, **1**, 10 (1954).

⁷ Franklin, R., *Nature*, **175**, 379 (1955).

⁸ Knight, C. A., *J. Amer. Chem. Soc.*, **71**, 3108 (1949).

⁹ Hershey, A. D., and Chase, M. J., *J. Gen. Physiol.*, **36**, 29 (1952).

¹⁰ Schmidt, P., Kaesberg, P., and Beeman, W. W., *Biochim. Biophys. Acta*, **14**, 1 (1954).

X-Ray Diffraction by an Abnormal Protein (B8) associated with Tobacco Mosaic Virus

From extracts of plants infected with tobacco mosaic virus, proteins related to the virus but not associated with ribonucleic acid have been isolated independently in three laboratories¹⁻³. These abnormal non-virus proteins are immunochemically related to tobacco mosaic virus, and have the property of polymerizing to rod-shaped particles similar to those of tobacco mosaic virus. X-ray diffraction studies of one such preparation of polymerized non-virus protein have been reported by Rich, Dunitz and Newmark in the preceding communication (we are much indebted to these authors for sending us their manuscript before publication). The present communication describes some preliminary X-ray diffraction measurements on a preparation of the polymerized non-virus protein which Commoner⁴ has designated B8.

The observations reported here differ in some respects from those of Rich, Dunitz and Newmark. We shall therefore first consider how our B8 preparation may differ from their 'abnormal protein'.

Takahashi⁵ reported two abnormal non-virus proteins designated 'X' and 'short particles' respectively. Commoner *et al.*⁶ described three abnormal non-virus proteins, A4, B3 and B6. The most recent results reported by Jeener *et al.*⁷ indicate the presence of two abnormal components. Each of the above low-molecular weight unpolymerized components is capable of polymerizing to form a high-molecular weight rod.

Comparison of the electrophoretic patterns of Takahashi and of Jeener with those of Commoner indicates that: (a) component B6, which polymerizes to form B7, is equivalent to Takahashi's 'short particles' and to Jeener's more rapid component; (b) component B3, which polymerizes to form B8, is equivalent to Takahashi's 'X' and to Jeener's slower component. The B8 used in the present investigation should thus be equivalent to Takahashi's 'polymerized protein X'.

Recently, however, Delwiche *et al.*⁸, and Rich *et al.*⁹, have found only a single abnormal non-virus protein, to which they refer as "the abnormal protein". Recent investigations by one of us (B.C.) indicate a possible source of this discrepancy. It has been found that solutions containing mixtures of components B3 and B6 will, upon standing in the cold, co-polymerize to form a single high-molecular weight component which is very similar to B8. Examination of the process employed by Delwiche *et al.* to prepare their 'abnormal protein' suggests that their preparations may contain such a co-polymer of B3 and B6 rather than pure B8.

It is therefore possible that minor differences between the X-ray diffraction patterns of B8 and of the 'abnormal protein' of Rich *et al.* may be due to minor differences of constitution, of the type here described. We think it unlikely, however, that there is any major structural difference between the two preparations.

The B8 protein used in the present investigation was prepared in the form of a highly purified solution of concentration about 0.3 per cent and preserved in a dialysis sack suspended in distilled water. The volume was afterwards reduced between 50- and 100-fold by allowing water to evaporate slowly through the dialysis sack. The resulting concentrate contained fibrous regions of gel showing weak positive

birefringence, suspended in non-birefringent liquid. When this suspension is introduced into a glass capillary tube, the regions of fibrous gel align themselves approximately parallel to the axis of the tube. X-ray photographs of the gel were obtained from material orientated in this way.

Dry orientated specimens were obtained by drying the gel suspension through a meniscus between two glass plates, according to the method of Bernal and Fankuchen¹⁰. It was found that, as water was removed from the gel, the birefringence decreased, passed through zero, and finally became negative. The dry B8 has a negative birefringence approximately equal in magnitude to the positive birefringence of dry tobacco mosaic virus.

X-ray fibre diagrams of dry B8, of B8 dried and afterwards humidified by maintaining in an atmosphere of 75 per cent relative humidity, and of B8 gel, are compared, in Figs. 1, 2 and 3 respectively, with the X-ray fibre-diagram of a tobacco mosaic virus gel. A high-resolution photograph of the central region of Fig. 1 (dry B8) has also been obtained, and shows a series of equatorial reflexions corresponding to a close-packed assembly of rods of diameter 150 Å. The intensities of these reflexions agree fairly well with those reported by Rich *et al.*, except that a reflexion at 65 Å. is sharp and of medium strength, and one at 49 Å. is weak but clearly visible.

The resemblance between the X-ray photographs of B8 and those of tobacco mosaic virus may perhaps appear rather slender. However, the strong similarity between B8 and tobacco mosaic virus protein in other respects (immunochemical cross-reactions, size of the basic chemical unit, and diameter of the rod-shaped particles) makes it very probable that a close structural relationship exists. It therefore seems justified to relate the prominent meridional maxima of the B8 diagrams to the near-meridional regions of high intensity in tobacco mosaic virus. (The less good orientation in the B8 diagrams makes it impossible to say whether or not the maxima are truly meridional.)

The most striking feature of the diagrams shown in Figs. 1, 2 and 3 is that the fibre-axis spacings given by the prominent meridional maxima in B8 vary by more than 20 per cent with changing water content. In tobacco mosaic virus the axial spacings are the same whether the virus be dry, moist, or in the gel state.

X-ray diffraction studies^{9,10} on tobacco mosaic virus have shown that the protein is in the form of units, of molecular weight probably about 30,000, set in helical array around the axis of the virus rod. The pitch of the helix is 23 Å., the fibre-axis repeat period of 69 Å. containing three turns of the helix. The strongest near-meridional diffraction in tobacco mosaic virus occurs on the 3rd and 6th layer-lines, corresponding to the first and second orders of the pitch of the helix.

The two principal meridional maxima of the dry B8 occur at slightly larger angles than those of tobacco mosaic virus, and indicate axial spacings about 6 per cent smaller than the tobacco mosaic virus spacings (Fig. 1). However, when water is added to B8, these maxima move towards the centre of the diagram. In the gel state the corresponding spacings are about 15 per cent larger than in tobacco mosaic virus (Fig. 3).

These results suggest that B8 protein forms a structure grossly similar to that of tobacco mosaic

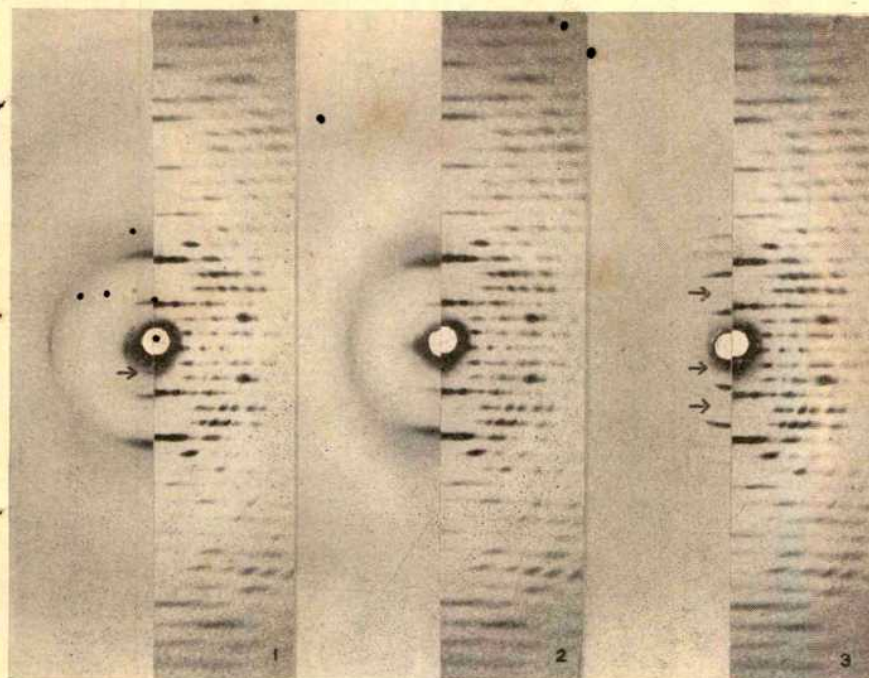


Fig. 1

Fig. 2

Fig. 3

X-Ray fibre diagrams of protein B8 (left-hand side of each figure) compared with fibre-diagrams of orientated tobacco mosaic virus gel.

(1) B8 dry. (2) B8 previously dried, then maintained at 75 per cent relative humidity. (3) B8 orientated gel.

Arrows in photographs indicate positions of meridional or near-meridional maxima on 1st and 3rd layer-lines of B8

virus protein, but more loosely held together. In tobacco mosaic virus, X-ray diffraction studies¹⁰ have led to the conclusion that there is a marked structural discontinuity at the geometrical interface between one turn of the helix and the next. It is probable that there is no specific chemical bonding across this interface. (Further evidence of this has recently been obtained by one of us (R. E. F.) and will be published shortly.) Successive units along the tobacco mosaic virus helix, on the other hand, appear to be strongly linked, and it is this linking which is probably similar to that which occurs when B3 polymerizes to form B8. In tobacco mosaic virus the resultant helical structure is highly regular and rigid. In B8, due partly, perhaps, to the absence of ribonucleic acid, the polymerized protein can expand and shrink with changing conditions.

Two possible mechanisms for the change in length of B8 can be suggested. If the polymerization of B3 to B8 produced a helical structure like that of tobacco mosaic virus protein, then the changes of length in such a structure might be supposed to take place in a manner analogous to the stretching and retraction of a coiled spring. One important feature of the X-ray diagrams of B8 is, however, difficult to reconcile with this picture. Whereas in tobacco mosaic virus, and also in the abnormal protein of Rich, Dunitz and Newmark, the principal near-meridional maxima occur on the 3rd and 6th layer-lines, in B8 the layer-lines on which the corresponding maxima lie are the 2nd and 4th. Weak but distinct meridional or near-meridional maxima occur on the 1st, 3rd and 5th layer-lines of B8. The positions of the strongest of these are indicated by arrows in Figs. 1 and 3. It is the presence of these

maxima which is, apparently inconsistent with the existence in B8 of a helical structure similar to that of tobacco mosaic virus.

Since the tobacco mosaic virus helix is a rather flat one, a quite small geometrical distortion could lead to the formation of a cyclic rather than a helical polymer from the same protein building units. The resulting flat, cyclic polymer units might then stack one above the other to form a rod the structure of which is grossly similar to that of tobacco mosaic virus protein. If the formation of B8 from B3 occurs by such a mechanism, then the near-meridional maxima on the 1st, 3rd and 5th layer-lines could be explained provided that the cyclic units were somehow associated in pairs when stacked. The change in length of the polymer rod with changing water content would then be due to the penetration of up to two monolayers of water between neighbouring cyclic polymer units.

If we are right in thinking that the structure of B8 is closely related to that of tobacco mosaic virus protein, then considerable importance must be attached to the reversal of the sign of birefringence in B8. We must conclude that the ribonucleic acid makes a positive contribution to the birefringence of tobacco mosaic virus, and hence that the purine and pyrimidine rings are aligned approximately parallel to the axis of the particle. If the ribonucleic acid in tobacco mosaic virus forms a central core (see Rich *et al.* and ref. 9), it follows that its structure must differ considerably from the structure of deoxyribonucleic acid described by Crick and Watson¹¹.

ROSALIND E. FRANKLIN
Birkbeck College Crystallography Laboratory,
University of London,
21 Torrington Square,
London, W.C.1.

BARRY COMMONER
Henry Shaw School of Botany,
Washington University,
St. Louis, Missouri. March 24.

¹ Commoner, B., Newmark, P., and Rodenberg, S. D., *Arch. Biochem. and Biophys.*, **37**, 15 (1952).

² Commoner, B., Yamada, M., Rodenberg, S. D., Wang, T.-Y., and Basler, E., *Science*, **118**, 529 (1953).

³ Takahashi, W. N., and Ishii, M., *Phytopath.*, **42**, 600 (1952).

⁴ Takahashi, W. N., and Ishii, M., *Amer. J. Bot.*, **40**, 85 (1953).

⁵ Jeener, R., Lemoine, J., and Lavand'homme, C., *Biochim. Biophys. Acta*, **14**, 321 (1955).

⁶ Commoner, B., and Yamada, M., *J. Gen. Physiol.*, **38**, 459 (1955).

⁷ Delwiche, C. C., Newmark, P., Takahashi, W. N., and Ng, M. J., *Biochim. Biophys. Acta*, **16**, 127 (1955).

⁸ Bernal, J. D., and Fankuchen, I., *J. Gen. Physiol.*, **25**, 411 (1941).

⁹ Watson, J. D., *Biochim. Biophys. Acta*, **13**, 10 (1954).

¹⁰ Franklin, R. E., *Nature*, **155**, 379 (1955).

¹¹ Crick, F. H. C., and Watson, J. D., *Proc. Roy. Soc., A*, **223**, 80 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of Delayed Acoustic Feed-back on some Non-vocal Activities

It is well known that difficulties in speaking will result if the speaker is made to listen to the sound of his own voice delayed by about 0.1–0.3 sec. This delayed feed-back will produce stuttering, reduced rate of speaking, distortion of sound quality and other impairments of speech¹.

It was thought interesting to find out how far delayed acoustic feed-back would affect non-vocal activities which one might expect to be controlled more by other means, for example, by proprioception or the sense of touch. Exploratory experiments showed that whistling and the playing of musical instruments were, in fact, strongly influenced by delayed acoustic feed-back, and even such comparatively simple activities as rhythmical hand clapping were disorganized. Results of some experiments of the last type are given below.

In the experiment, any sound produced by the subject was recorded and played back through headphones either immediately or with a delay of about 0.25 sec. Whereas acoustic feed-back was thus controlled, all other sensations such as touch or proprioception connected with the clapping of hands reached the subject without artificial delay. There was also an electronic metronome that produced short timing clicks in his ear at 2-sec. intervals; this was never delayed. The sound of the handclaps and the metronomic beats were recorded on a second tape recorder in the normal way for later analysis. A pen recorder was used for obtaining from the second record traces of the type shown in Fig. 1. The claps appear as clearly distinguishable deflexions of the pen, and the metronome clicks are indicated by short sharp spikes.

The subject's first task consisted in clapping his hands as regularly as possible six times following each metronome click. Fig. 1*a* shows that this was accomplished quite easily when there was no acoustic delay; when a 0.25 sec. delay was introduced

(Fig. 1*b*), hands were often clapped seven times instead of six times, and at other times clapping ceased altogether after alternate clicks.

The second task consisted in clapping two groups of three beats after each metronome click with a strong accent on the first clap in each group. Playing back without delay again did not disrupt the performance (Fig. 2*a*); but delay of 0.25 sec. almost invariably resulted in four claps being produced in the second group instead of three (Fig. 2*b*). It should be mentioned that the subjects were sometimes aware of their mistakes and tried more or less successfully to overcome them, usually by concentrating on the task and slowing down the performance. In other cases, however, people were unaware of their mistakes.

These short preliminary experiments show that acoustic feed-back plays an important part in the performance of tasks which one would have thought to be controlled more by reafference from other senses. It seems that every hearing person is subject to these effects to some degree; but the response varies a great deal between people, and the study of this variation promises some insight into individual development and possibly into the genetics of certain faculties concerned with rhythm and counting.

H. KALMUS

Galton Laboratory,

P. DENES

D. B. FRY

Department of Phonetics,

University College,

London, W.C.1.

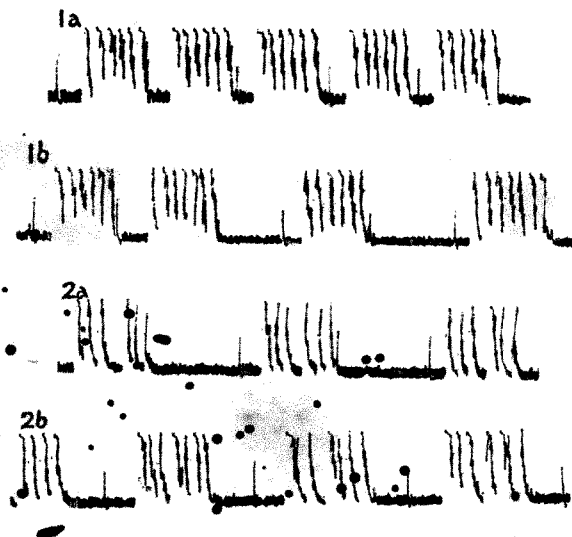
March 30.

¹ Lee, B. S., *J. Acous. Soc. Amer.*, **22**, 825 (1950). Black, J. W., *J. Speech and Hearing Disorders*, **18**, 56 (1951).

Improved Resolution with the X-Ray Projection Microscope

A RESOLUTION of 0.1 μ (1000 Å.) has now been reached with the shadow type of X-ray microscope by using a thin gold-leaf X-ray target. The instrument described previously by Cosslett and Nixon¹⁻⁴ was limited to a resolution of 0.5 μ due to astigmatism in the electron lens and to electron scattering in the metal target. An attempt was made to reduce the astigmatism by stopping down the aperture of the objective lens used for focusing the electrons. No improvement in resolution was found even for a semi-angular aperture of 2×10^{-2} rad. giving an astigmatic disk of confusion of 0.2 μ for the worst possible machining errors of the pole pieces. This indicated that electron scattering in the metal foil target was the true limit on resolution.

An electron-range of 0.2 μ in gold at 10 kV. is found from the Thomson-Whiddington law⁵, and the scattering angles can be very large at this low voltage. In this way the X-rays used for shadow microscopy could have been produced anywhere in a hemisphere of radius 0.2 μ , in good agreement with the previous resolution. Recently, Ehrenberg and Franks⁶ have shown that the electron-range is even greater than this in transparent phosphors at this kilovoltage. It might be thought that the effect of electron-scattering in the target could be reduced considerably by evaporating a layer of heavy metal, such as gold or tungsten, on to a thicker beryllium foil to provide



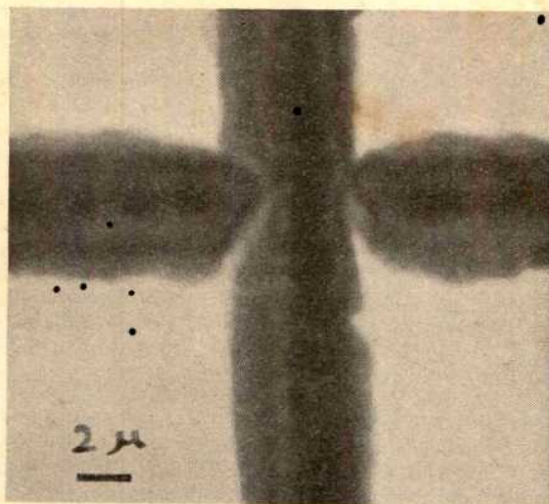


Fig. 1. Contamination of a 1,500 mesh/in. test grid by electron bombardment at atmospheric pressure. X-ray micrograph, using 0.1μ gold-leaf X-ray target. ($\times 3,600$.) 5-min. exposure, 10 kV.

mechanical support. This type of X-ray microscope target has been suggested^{7,8} and used^{9,10}; but no improvement in resolution was found. If the metal layer is less than half the penetration-range, and this is not exactly known in view of Ehrenberg and Franks's work⁶, then 5 per cent of the X-rays generated will come from a region of the beryllium of diameter 2μ and will spoil the improved resolution. Evaporated layers much less than the penetration-range would be chosen to give a large improvement, and in this case a much greater percentage of X-rays would come from the beryllium. In fact, reasonable X-ray micrographs of a 1,500 mesh/inch silver grid with a resolution of 2μ and a 5-min. exposure at 10 kV. have been obtained from beryllium only, with no heavy-metal layer.

An X-ray target of beaten gold leaf, 0.1μ thick, stretched over a 100μ aperture, has been used for reaching a resolving power of 0.1μ for the X-ray shadow projection microscope. Such a foil target supports atmospheric pressure without being so

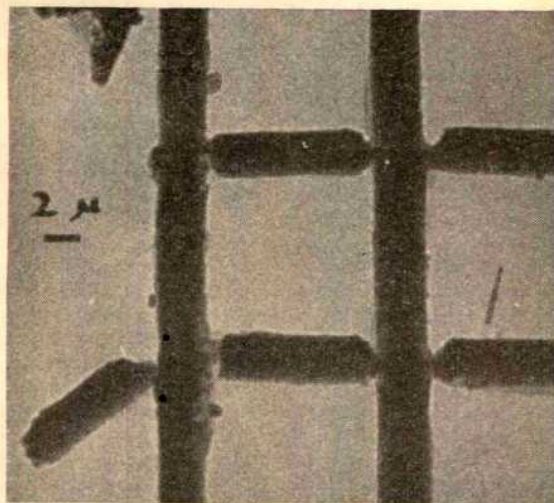


Fig. 2. X-ray micrograph of a 1,500 mesh/in. test grid (uncontaminated), showing Fresnel edge diffraction fringes of width 0.1μ. ($\times 2,000$.) 5-min. exposure, 10 kV.

porous as to leak unduly, and does not break for high electron current densities if the spot is less than 1μ . Many electrons penetrate the foil and strike the specimen (50μ beyond), causing electron-induced contamination as in the electron microscope. A test grid is shown in Fig. 1 at 3,600 $\times$, demonstrating the 'padding' of the grid bars by contamination and demonstrating the new resolution. The rate of formation, 2 A./sec. or 0.7μ/hr., is similar to that found in the electron microscope¹¹, although this contamination occurs at atmospheric pressure and without pump oil vapour present. This result seems to favour the condensation theory of Ennos¹¹ or even a return to the ionization postulate of Watson¹²; further work on contamination by this new method is being carried out.

With this improved resolution Fresnel edge diffraction fringes of 0.1μ width are seen when the specimen and photographic plate are correctly placed. A test grid with such a fringe is seen in Fig. 2 at 2,000 $\times$. It is suggested that the minimum first fringe width of this edge diffraction pattern be used as a resolving-power test for all X-ray microscopes. Specimen and plate distances could in principle be adjusted to record a fringe equal to a resolving power even as good as 100 A.

The unexplored region beyond the ultra-violet microscope, with the specimen at atmospheric pressure, will become accessible if the resolution can be improved still further. To do this it will be necessary to use even thinner gold-foil targets, voltages in the 2–5 kV. region to reduce electron penetration and increase contrast, and possibly some astigmatism correction of the magnetic or electrostatic lens used.

W. C. NIXON

Cavendish Laboratory,
Cambridge.
Feb. 21.

¹ Cosslett, V. E., and Nixon, W. C., *Nature*, **168**, 24 (1951).

² Cosslett, V. E., and Nixon, W. C., *Nature*, **170**, 436 (1952).

³ Cosslett, V. E., and Nixon, W. C., *Proc. Roy. Soc., B*, **140**, 422 (1952).

⁴ Cosslett, V. E., and Nixon, W. C., *J. App. Phys.*, **24**, 616 (1953).

⁵ Whiddington, R., *Proc. Roy. Soc., A*, **89**, 554 (1914).

⁶ Ehrenberg, W., and Franks, J., *Proc. Phys. Soc., B*, **66**, 1057 (1953).

⁷ Marton, L., Nat. Bur. Standards (Washington), Circular 527, p. 265. Symposium (1951).

⁸ Pattee, H. H., *J. App. Phys.*, **43**, 61 (1953).

⁹ Newberry, S. P., and Summers, S. E., *Proc. Int. Conference on Electron Microscopy*, London, July 1954, Paper 69.

¹⁰ Nixon, W. C., *Proc. Int. Conference on Electron Microscopy*, London, July 1954, Paper 70.

¹¹ Ennos, A. E., *Brit. J. App. Phys.*, **5**, 27 (1954).

¹² Watson, J. H. L., *J. App. Phys.*, **18**, 153 (1947).

An Alternative Identification of the Radio Source in the Direction of the Galactic Centre

A RADIO source the co-ordinates of which agree closely with those of the centre of the Galaxy has been reported by several observers, and it has been suggested that it may be identified with the nucleus of the Galaxy¹⁻³. The galactic co-ordinates of this source are $l = 32^\circ$ and $b = -2^\circ$, and it is designated 1752A in the list recently published by the International Astronomical Union⁴. The apparent angular diameter of the source has been observed by Mills⁵ to lie between 1° and 1° at 100 Mc/s. An independent estimate made at Jodrell Bank at 1,420 Mc/s. indicates that the diameter is 1° .

If the identification of this source with the nucleus of the Galaxy is accepted, then at a distance of 8 k.parsecs the diameter of the nucleus would be about 150 parsecs, which is small compared with that of the nucleus of a typical spiral nebula similar to our Galaxy. Furthermore, a careful study of the radio isophotes in the direction of the galactic centre shows that this source is displaced considerably ($\sim \frac{1}{4}^\circ$) from the centre of symmetry of the isophotes, suggesting that it does not lie in the centre of the system.

In view of these doubts about the identification of the radio source with the galactic nucleus, an attempt has been made to determine its distance by means of the absorption by interstellar hydrogen at 1,420 Mc./s. The measurements have been carried out by two methods.

The first method is analogous to that used in optical astronomy for measuring the distance of stars by means of the equivalent width of interstellar absorption lines⁶. A detailed study has been made of the hydrogen line spectrum in the region of the galactic centre, and the absorption spectrum of the source has been found. The equivalent width of the absorption line is 65 kc./s. A study by us (unpublished) of the radio sources in Cassiopeia, Cygnus and Taurus indicates that there is a linear relationship between the equivalent width of the absorption line and the extent of the Galaxy between the observer and the source. These results suggest that a line-width of 65 kc./s. corresponds to a distance of 2.9 k.parsecs.

The second method⁷ depends upon a measurement of the absorption of the source at the centre frequency of the hydrogen line emission spectrum. Fig. 1a shows the drift curve taken across the source in continuous emission (away from the hydrogen line). Fig. 1b shows drift curves taken with the double-comparison spectrometer at the hydrogen-line frequency. The full line is taken across the source and

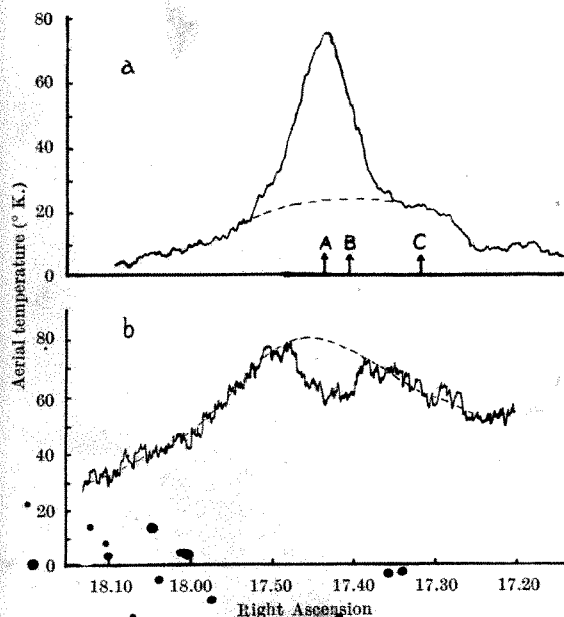


Fig. 1. (A) Position of source; (B) centre of background; (C) galactic equator ($b = 0$)

(a) Drift curve taken across the source in continuous emission. (b) Drift curves using the double comparison receiver at the hydrogen line frequency. The full line is taken across the source, and the dotted line is taken at a declination 2° from the source

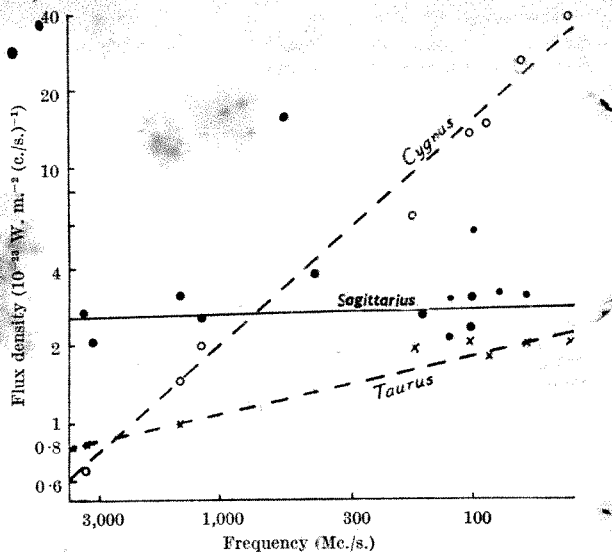


Fig. 2. Spectrum of the Sagittarius source (full line). The spectra of the Cygnus and Taurus sources (dotted lines) are shown for comparison

the dotted line is taken at a point closely adjacent to the source. These observations show that 36 per cent of the radiation from the source is absorbed at the hydrogen-line frequency. An estimate of the distance of the source can be made if the distribution of hydrogen and its kinetic temperature is known in the line of sight of the source. Taking the kinetic temperature of the hydrogen to be 100°K. , and estimating the distribution of the hydrogen from the available surveys of the Galaxy⁸, it can be shown that the observed absorption of 36 per cent will be reached in a distance of about 2.7 k.parsecs.

Although both these methods of measuring distances are subject to considerable errors, they are largely independent and they indicate strongly that the distance of the source is considerably less than that of the galactic centre (8.2 k.parsecs).

The spectrum of the source shown in Fig. 2 has been obtained from the published data^{1,3,9} (the intensities given in refs. 9a and b have been corrected for a source diameter of 1°). The spectra of the well-known sources in Cygnus (19N44) and Taurus (05N24) are shown for comparison. It can be seen that the spectrum is flat, which suggests that the emission is taking place in a region of optically thin gas. Taking a distance of 3 k.parsecs, the diameter of the source (about 1°), indicates that the extent of this region is about 50 parsecs. This evidence suggests that the radiation is taking place, not from the galactic nucleus but from an ionized region of gas situated at about 3 k.parsecs. An aggregate of thirty-eight early-type stars has been reported by Hiltner¹⁰ at a distance of 3 k.parsecs in a direction which corresponds precisely to that of the radio source. It is possible that this group of hot stars is associated with a nebulosity which, in the same way as the Orion and Trifid nebulae, gives rise to a radio source. There is heavy obscuration in this direction of the Galaxy, and therefore it is unlikely that such a nebulosity would be observed optically. Although no positive identification of the source with this group of stars can be made, it is suggested that it represents a more likely origin for the radiation than the galactic nucleus.

We wish to thank Prof. A. C. B. Lovell, the director of this Station, and Mr. R. Hanbury Brown for their interest in this investigation.

R. D. DAVIES
D. R. W. WILLIAMS

University of Manchester,
Jodrell Bank Experimental Station,
Lower Withington,
Macclesfield, Cheshire.
April 7.

- ¹ Bolton, J. G., and McGee, R. X., *Nature*, **173**, 985 (1954).
² Kraus, J. D., and Ko, H. C., Ohio State Univ. Rad. Obs., Report No. 1 (1954).
³ Hagen, J. P., and McClain, E. F., *Astrophys. J.*, **120**, 368 (1954).
⁴ Pawsey, L., *Astrophys. J.*, **121**, 1 (1955).
⁵ Mills, B. Y., *Aust. J. Sci. Res.*, **A**, **5**, 266 (1952).
⁶ Beals, C. S., and Oke, J. B., *Mon. Not. Roy. Astro. Soc.*, **113**, 530 (1953).
⁷ Williams, D. R. W., and Davies, R. D., *Nature*, **173**, 1182 (1954).
⁸ Kwee, K. K., Muller, C. A., and Westerhout, G., *Bull. Astro. Inst. Ned.*, **12**, 211 (1954).
⁹ (a) Hagen, J. P., Lilley, A. E., and McClain, E. F., N.R.L. Report 4448. (b) Haddock, F. T., Mayer, C. H., and Sloanaker, R. M., *Nature*, **174**, 176 (1954). (c) Kraus, J. D., and Ko, H. C., *Sky and Telescope*, **14**, 22 (1954). (d) Piddington, J. H., and Minnett, H. C., *Aust. J. Sci. Res.*, **A**, **4**, 459 (1951). (e) Bolton, J. G., Westfold, K. C., Stanley, J. G., and Slee, O. B., *Aust. J. Phys.*, **7**, 96 (1954). (f) Bolton, J. G., and Stanley, G. J., *Aust. J. Sci. Res.*, **A**, **3**, 234 (1950).
¹⁰ Hiltner, W. A., *Astrophys. J.*, **120**, 41 (1954).

Effect of Density Differences on the Path of Jets

In the application of model techniques to furnace design, a problem which has long resisted solution is the simulation of the buoyancy effect of hot flames rising within the cooler furnace atmosphere. An attempt is being made to solve this problem by the use of a water model.

The technique involves the use of a jet of magnetite slurry, which represents the flame jet, and water, which represents the combustion air. The jet of magnetite, being heavier than the surrounding water, sinks, and so provides an 'upside-down' picture of the rising flame-jet. A 'Perspex' box with dimensions 2.5 ft. × 2 ft. × 1 ft. represents the combustion chamber, into which water is pumped from a settling tank through a filter. The slurry is injected from a mixing drum, which is kept under pressure by a small blower. The discharge from the model returns to the settling tank, the water being recirculated.

During the development of this technique, it was found that the distribution of the jet did not agree with that predicted by the established formulae. The formula suggested by Groume-Grijmailo¹ for the path of an infinitely thin jet is not justifiable, because it contains the assumption that the horizontal velocity is constant, which is far from the truth. Davis² developed an expression to include the effect of this decreasing velocity due to entrainment. However, the displacement of the jet in a vertical direction according to Davis's formula is based on Newton's second law of motion assuming constant density of jet fluid. This again is incorrect because the density changes, also due to entrainment, until it approaches that of the surrounding fluid. If constant density is assumed, the vertical displacement is grossly exaggerated.

In the light of these observations was developed for the path of both the effect of varying velocity. If considerations are restricted to and to distances not less than 15 nozzle, the vertical displacement horizontally fired jet from a circle approximately by:

$$\frac{y}{D} = \frac{64 g s K_{11}^2 D}{U_0^2 A^2} \left[\frac{\sqrt{A}}{3} \left(\frac{x}{D} \right)^3 - \frac{S}{2} \left(\frac{x}{D} \right) \right]$$

where y is displacement in vertical direction; x is horizontal displacement; U_0 is velocity at the nozzle; L is the nozzle length; ρ_0 and ρ_s are densities of jet and surrounding fluid; B is

$$B = \left(\frac{\rho_0 - \rho_s}{\rho_s} \right) \left(\frac{K_{11}}{2k(\mu + 1)} \right); K_{20} \text{ is } 1/4k; K_{21} \text{ is } 1/4k; K_{22} \text{ is } 1/4k$$

K_{11} , K_{20} , K_{21} arise from the functions to which the concentration profiles in the jet are assumed constants deduced by extrapolation from experimentally determined by K_{11} and K_{20} .

Fig. 1 is a photograph of a jet from a nozzle of 0.125 in. diameter. The path is shown by the dotted line. The comparison of predicted and actual path, the axis of the jet being as shown, is symmetrically within the jet boundary.

x/D	y/D	y/D predicted by equation
24	0	0.2
48	3.6	2.7
72	11.8	10.1
96	28.6	25.2
120	47.2	50.6
144	77.0	88.6

A technique is being developed to measure the jet quantitatively, and it is hoped that it will be of use in the future.

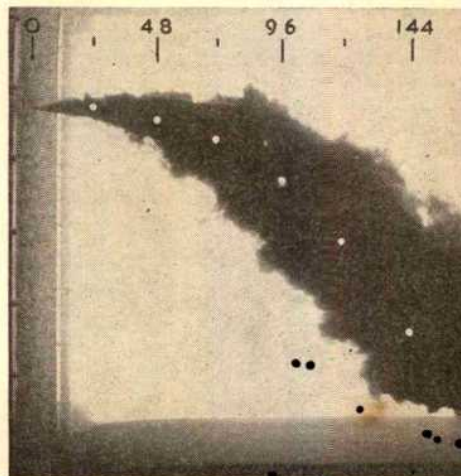


Fig. 1

furnish further information concerning the influence of density differences on the path of jets.

G. HORN
M. W. THRING

Department of Fuel Technology,
University of Sheffield.
Feb. 3.

¹ Groume-Grijmallo, W. E., "The Flow of Gases in Furnaces" (Chapman and Hall, London, 1923).

² Davis, R. F., *Proc. Inst. Mech. Eng.*, 137 (1937).

³ Taylor, J. F., Grimmer, H. L., and Comings, E. W., *Tech. Prog. Report No. 2, Fluid Mixing Research, Eng. Exp. Station, Univ. Illinois* (1948).

⁴ Hawthorne, W. R., doctorate thesis, Mass. Inst. Tech., Cambridge, Mass. (1939).

⁵ Keagy, W. R., and Weller, A. E., "A Study of Expanding Inhomogeneous Jets" (Battelle Mem. Inst., Columbus, Ohio, 1949).

Fluorescent Centres in Uranium-activated Sodium Fluoride

THE sodium fluoride fusion method is commonly used for the determination of minute amounts of uranium¹. The sample to be tested is fused in a platinum crucible with sodium fluoride, and the fluorescence is measured in a fluorimeter. By this method, amounts of uranium down to 10^{-10} gm. can be determined in 0.2 gm. of fluoride.

Sodium fluoride containing uranium has a bright yellow-green fluorescence when excited by long-wave ultra-violet radiation. Even at room temperature the emission consists of broad bands partially resolved into lines, and at 77° K. the spectrum consists of more than twenty lines (see Fig. 1). This emission has been described by Slattery², who concluded that the uranium is in solid solution with the fluoride. The fluorescence would then be attributed to a UF_6 group. Solid UF_6 , however, has a bright violet fluorescence bearing little resemblance to the sodium fluoride (uranium) emission.

Another possibility which has been considered in the past is that the fluorescence belongs to a uranyl group. The fluorescence exhibits the right colour, but does not show the characteristic unresolved bands at room temperature or the repetition frequency of about 860 cm^{-1} .

A consideration of the principle of localized charge compensation³ has suggested another solution to this problem. Supposing a uranium ion in the hexavalent state replaces a sodium ion, then there will be an excess of five units of charge. This can be compensated either by positive ion vacancies or by divalent negative ions. As the samples are melted in air, and since the uranium is often present as a uranyl group, it is quite probable that charge compensation can occur by the entry of oxygen ions, five being necessary to give perfect compensation. The relative simplicity of the emission spectrum indicates a highly sym-

metrical arrangement, and in view of the known stability of octahedral UO_6 groups in alkaline-earth oxide⁴ and uranate⁵ phosphors, it is concluded that the six fluorines surrounding the uranium ion are replaced by oxygens. This hypothesis explains both the colour of the emission, which is characteristic of U—O bonding, and the repetition frequency of about 740 cm^{-1} characteristic of the UO_6 group³.

The centre has now a net charge of minus one and can attract ions with an excess positive charge. In particular, a divalent ion in the nearest positive ion site will cause complete charge neutrality. This is especially significant, as it has been shown⁶ that small quantities of divalent ions, for example, calcium or magnesium, can cause an anomalous enhancement of the fluorescence of uranium in alkali-metal carbonate fluxes containing sodium fluoride.

In the present investigation it has been found that there is a marked change in the line intensities of the spectra, when calcium, in this case as chloride, is added to sodium fluoride (uranium) (see Fig. 1). This occurs when the atomic percentage of both the uranium and calcium is less than 0.1; and it is difficult to see how the relative intensities of the principal lines can change, as shown, unless pairing of the uranium and calcium ions occurs.

This conclusion is in disagreement with that of previous authors⁶, who based their argument on the observation that the percentage quenching of an impurity is independent of the concentration of uranium. This independence has not been fully verified by other workers⁷, although the variation with uranium concentration is not great.

It is hoped to extend these preliminary observations and to publish a fuller account at a later date.

W. A. RUNCIMAN

Atomic Energy Research Establishment,
Harwell, Didcot, Berks.
March 3.

¹ Price, G. R., Ferretti, B. J., and Schwarz, S., *Anal. Chem.*, 25, 322 (1953).

² Slattery, M. K., *J. Opt. Soc. Amer.*, 19, 175 (1929).

³ Runciman, W. A., Cambridge Conference on Luminescence, *Brit. J. App. Phys.*, Supp. No. 4, S78 (1955).

⁴ Steward, E. G., and Runciman, W. A., *Nature*, 172, 75 (1953).

⁵ Jacobs, S., *CRL/A.E.*, 54 (1950).

⁶ Price, G. R., Ferretti, B. J., and Schwarz, S., *A.E.C.D.*, 2282 (1945).

⁷ Walton, G. N., Hutton, G., and Dalziel, J. A. W., *A.E.R.E. C/R* 966 (1952).

A Method of measuring Stress in Dentures

THE high incidence of midline fracture in polymethyl methacrylate full upper dentures has prompted an investigation as to its cause.

During the course of the work, a simple technique for the analysis of the stress distribution over the surface of a denture has been developed. The method adopted uses a brittle lacquer ("Strainlac", manufactured by R. D. Walker, Vine Cottage, Corbridge, Northumberland) which has found industrial application as a tool of experimental stress analysis. Briefly, the technique is as follows. The lacquer is sprayed on to the outer surface of the denture and allowed to dry. The coating is 0.003–0.007 in. thick. The denture is then stressed in the mouth and cracks appear in the lacquer wherever the tension stress exceeds a certain value defined by the strain-sensitivity of the lacquer. The cracks may be shown up more clearly by brushing a dye etchant on to the lacquer surface. Fig. 1, a photomicrograph of the



Fig. 1. Fluorescence at 77° K. with 3650 Å. excitation. (a) sodium fluoride (0.1 per cent uranium); (b) sodium fluoride (0.1 per cent uranium, 0.1 per cent calcium chloride). The spectra were obtained on an Astra III plate using a medium quartz spectrograph.

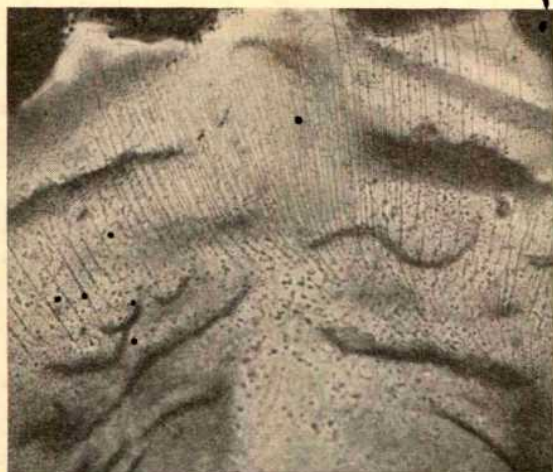


Fig. 1

region immediately behind the central incisors, shows an area of high stress, as indicated by a crowding of the crack lines. If a clear denture of polymethyl methacrylate is used, the cracks may be illuminated for photographic purposes, either by transmitted light (Fig. 1) or reflected light. Small areas of the main pattern may be photographed using reflected light, whereas larger areas may be photographed using transmitted light with slight loss of definition.

As yet, only qualitative analysis of the crack pattern on denture bases has been attempted until more information is available about the behaviour of the lacquer on plastic surfaces. Used qualitatively, however, the lacquer provides a quick method of indicating; (a) the points of high stress concentration; and (b) the direction of the principal stresses, since a crack runs perpendicular to the direction of the principal stress, which is a maximum and tensile. This information is sufficient to allow strain gauges to be placed on the surface at the most advantageous points. It also allows for the orientation of the gauges, one being placed in the direction of the major principal stress, the other at right-angles in the direction of the minor principal stress. From a knowledge of the strains in these two directions, together with the elastic constants of the material, the major and minor principal stresses may be computed.

Acknowledgments are due to Dr. J. H. Lamble, senior lecturer, Department of Mechanical Engineering, University of Manchester, for his assistance. This work is being carried out under the supervision of Prof. E. Matthews.

E. A. WAIN

Turner Dental School,
University of Manchester.
Jan. 26.

The Amorphous Alloy

IN 1920 Rosenhain, Haughton and Bingham¹ described a zinc/aluminium/copper alloy (89/7/4) the mechanical properties of which resembled those of an amorphous material, in that it was ductile at room temperature when deformed slowly but brittle when deformed quickly. A simple demonstration of this was that a piece of sheet made from the metal would bend double if bent slowly but snapped if bent quickly, just like an amorphous material such

as pitch. It appears that no satisfactory explanation of this behaviour has been put forward that conforms with modern ideas.

Impact tests have been made on specimens of this alloy supplied by Mr. A. E. L. Tate, who demonstrated that, in sheet form, it behaved as described above. The impact tests were made in a Charpy machine on notched specimens (for convenience the notches were of the Izod type) over a range of temperatures from about -200°C. to $+300^{\circ}\text{C.}$; for the tests above room temperature, specimens were immersed for 15 sec. in oil maintained at the desired temperature and then tested in about 4 sec. The results are shown in Fig. 1.

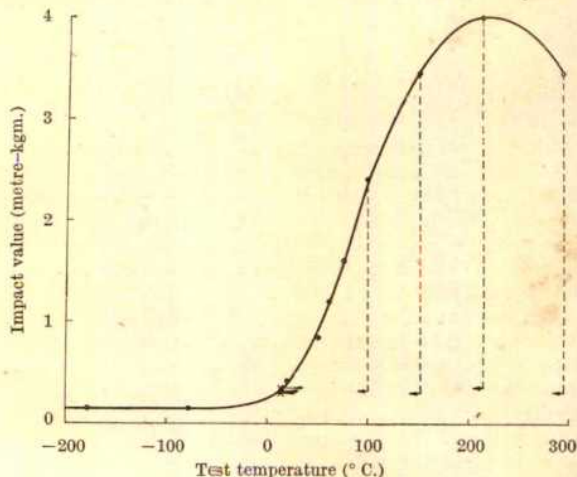


Fig. 1

The significant feature is the tough-brittle transition that takes place in the range $+200^{\circ}\text{C.}$ to 0°C. To check that this was not due to a structural change brought about by warming, duplicate specimens were quenched into water at 13°C. from the different temperatures and quickly tested; the values so obtained are shown by crosses and clearly lie on the main curve, signifying that no structural change had taken place that affected the impact value. The alloy therefore shows a genuine tough-brittle transition.

A property of the tough-brittle transition phenomenon is that the temperature range of the transition depends on the speed of testing; it falls as the speed is decreased. The fact that this alloy shows a tough-brittle transition in the neighbourhood of room temperature then explains the behaviour described in the first paragraph: in a fast test such as rapid bending, the transition range is high and room temperature lies in the brittle region; in a slow test such as gradual bending, the transition range is lower and room temperature lies in a more ductile region.

The work described here has been carried out as part of the general research programme of the National Physical Laboratory, and this communication is published by permission of the Director of the Laboratory.

D. MCLEAN

Metallurgy Division,
National Physical Laboratory,
Teddington.

April 19

¹ Rosenhain, W., Haughton, J. L. and Bingham, K. E., *J. Inst. Met.*, 23, 26 (1920).

Paper Electrophoresis of Reducing Agents

CONTINUING the study of trace substances in photographic gelatin^{1,2}, paper electrophoresis is being used for investigating the reducing agent present. The main interest is in the substance(s) which react immediately with iodine.

Fig. 1 (a photograph of the original electrogram) shows the separation of three anionic reducers, known or suspected to occur in gelatin. The apparatus used was as previously described; the paper was soaked in a pH 7 buffer prepared by mixing 2 lit. of 0.2 M disodium hydrogen phosphate with 500 ml. of 0.1 M citric acid. Sodium sulphite and thiosulphate were applied to the paper as 0.1 M solutions and reductone as a 0.05 M solution, neutralized with alkali. The duration of the run was two hours.

Compounds could be located as white spots on a coloured background by spraying the dried paper with either N/100 iodine or 0.025 per cent phenolindo 2:6 dichlorophenol, both in methanol or ethanol. The spots appear instantaneously on the iodine-treated paper. In the case of the dyed paper, there is a delay of about five minutes before the sulphite reacts and a longer delay with thiosulphate, although large spots are ultimately produced, since peripheral areas of low concentration react. The electrogram of Fig. 1 had been treated with dye. Silver nitrate is not a convenient reagent, as it is not decomposed by sulphite.

There is as yet no established way of presenting results derived by paper electrophoresis, probably because experimental conditions, for example paper texture, are hard to reproduce exactly. A kind of R_F value can be found by taking the ratio of the distance from the origin of any particular compound to that of a convenient reference compound, which may be thiosulphate in the present instance, in order to provide a link with the earlier results². Even this characteristic, however, tends to fluctuate. Thus, in eight determinations, the R_F value (as defined) varied from 0.69 to 0.75 for sulphite and from 0.43 to 0.50 for reductone. The observed mobility of thiosulphate was of the same order as in the earlier experiments using a phthalate buffer. The actual distances moved by thiosulphate in two hours under a potential gradient of 5.2 V./cm. ranged from 9.2 to 11.7 cm. The mobility of

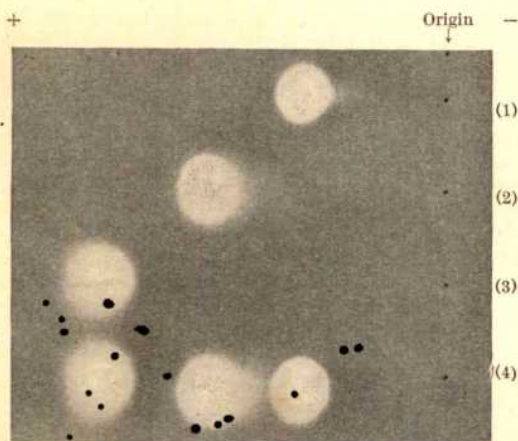


Fig. 1. Separation of anionic reducing agents: (1) reductone, (2) sulphite, (3) thiosulphate, and (4) mixture

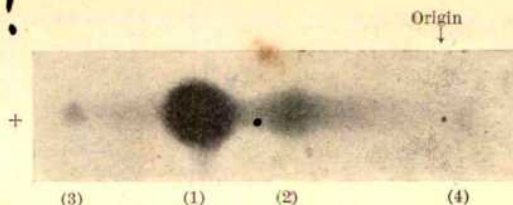


Fig. 2. Examination of aged reductone solution

the sulphite ion corresponds with that of pentathionate.

Other possible reducers can also be dealt with. Ascorbic acid and glutathione (taken as a model for a cysteine-containing polypeptide) both move towards the anode, but less rapidly than reductone, their R_F values, again relative to thiosulphate, being about 0.3 and 0.2, respectively. Cysteine moves very slightly towards the cathode; this is ascribed to the operation of an electro-osmotic effect. All three compounds reduce iodine and the dye reagent immediately. Ascorbic acid can be separated completely from reductone in a 2-hr. run. A feature of the result given by ascorbic acid is that a tail slowly develops to the main spot; this has been traced to decomposition of the compound on the paper. The differentiation of dienols such as reductone and ascorbic acid has previously been effected by Mapson and Partridge³ using paper chromatography.

Reductone was prepared for the present experiments by the method of von Euler⁴. The purity of the recrystallized specimen was confirmed by the finding that it gave rise to a single spot only. Paper electrophoresis is likely to prove useful in the investigation of compounds related to, or derived from, reductone. Fig. 2 shows the result given by a partially decomposed alkaline solution of reductone. A special aldehyde reagent⁵, which has the advantage of giving differently coloured spots, was used to locate the compounds. The paper was sprayed with a 0.5 per cent solution of thiobarbituric acid in acetic acid, and then heated for 5 min. at 80°C. The numbers placed under the electrogram refer to spots which were clearly visible in the original. The main spot (1) due to undecomposed reductone was bright yellow in colour. The main decomposition product gave rise to a reddish-brown spot (2); the mobility of this compound is slightly greater than that of ascorbic acid, from which it may be distinguished by the fact that pure ascorbic acid gives no colour with the reagent. (The tail which forms on the ascorbic acid spot during electrophoresis of the latter does react and produces a yellow colour.) Other fainter spots (3 and 4) are also in evidence. The compounds responsible for 2 and 3 have not yet been identified; 4 seems to correspond with glyceraldehyde, which was postulated by Sattler *et al.*⁶ as a product of the alkaline degradation of sugar.

The above observations on the colour of the spots given by reductone and the aged solution suggest that the band observed by Landucci⁷ at 535 mμ in the absorption spectrum of the reaction product of reductone and thiobarbituric acid is due, not to reductone itself, but to a degradation product.

It is hoped to describe the application of this work elsewhere. It is already clear that the reducing agent of photographic gelatin which reacts immediately with iodine is mainly sulphite. The latter is, of course, well known to be present in gelatins generally.

Thanks are due to the Directors of Ilford, Ltd., for permission to publish this communication.

H. W. WOOD

Ilford Research Laboratory,
Ilford, Ltd.,
London.
Feb. 9.

¹ Wood, H. W., *Sci. et Indust. Phot.*, **23**, 209 (1952).

² Wood, H. W., *J. Phot. Sci.*, **2**, 154 (1954).

³ Mapson, L. W., and Partridge, S. M., *Nature*, **164**, 479 (1949).

⁴ von Euler, H., and Martius, C., *Ann.*, **505**, 73 (1933).

⁵ Dox, A. W., and Plaisance, G., *J. Amer. Chem. Soc.*, **38**, 2156, 2164 (1916).

⁶ Sattler, L., and Zerban, P. W., *Sugar*, **42**, 26 (1947).

⁷ Landucci, J. M., *Bull. Soc. Chim. France*, **124** (1954).

Estimation of Phenolic Substances: Use of Stabilized *p*-Aminodiethylaniline

I REPORTED in a recent communication¹ that, in the presence of periodic acid as oxidant, ketosteroid salicyloylhydrazones couple readily with stabilized *p*-aminodiethylaniline to form intensely coloured blue-green indoanilines². Further investigation has made it clear that this reaction compares favourably with existing phenol reactions in respect of sensitivity, specificity, stability and optical properties.

Estimation of salicyloylhydrazones was carried out in the following way. To 5–50 $\mu\text{gm.}$ of the salicyloylhydrazone dissolved in 1 ml. ethyl acetate was added 1 ml. of 0.1 per cent solution of stabilized *p*-aminodiethylaniline (a sulphur dioxide compound of *p*-aminodiethylaniline marketed by Messrs. May and Baker as 'Genochrome'). 1 ml. of 5 per cent aqueous sodium bicarbonate was added, followed by 2 ml. of a saturated aqueous solution of potassium periodate. The reaction mixture was then shaken thoroughly to ensure intimate mixing of the two phases during the formation of the indoaniline. 3 ml. of water and powdered sodium chloride were then added, followed by the required amount of ethyl acetate. A crystal-clear intensely coloured supernatant organic phase resulted, which was decanted and read in a Spekker colorimeter against a blank determination using a suitable filter.

It was found that potassium ferricyanide was also effective as an oxidant, and the use of this technique is illustrated by the following method for the estimation of phenols. To 1–10 $\mu\text{gm.}$ of phenol dissolved in 1 ml. of water was added 0.4 ml. of 0.1 per cent stabilized *p*-aminodiethylaniline, 0.5 ml. of 0.33 per cent potassium ferricyanide and 0.5 ml. of 5 per cent potassium pyroborate, and the intensity of the colour was read directly. If less than 1 $\mu\text{gm.}$ of phenol is being estimated, the indoaniline should be extracted into *n*-butanol or chloroform. If necessary, the chloroform or *n*-butanol extract may be concentrated by distilling off some of the solvent, the colour remaining stable under these conditions.

As well as periodic acid and potassium ferricyanide, it was found that both silver nitrate and mercuric chloride were effective as oxidants; these findings are of potential application in histochemistry.

The reaction appears to be quite general for phenolic substances, some colour variation being obtained with different phenols.

The estimation of acid and alkaline serum phosphatases by determination of the liberated phenol as the indoaniline is under investigation. In that the colour is stable for some days and the proteins do not need to be precipitated, this method seems

preferable to existing methods. A full report of this work will be presented shortly.

I am grateful to Prof. J. Patterson for his guidance and to Miss J. Hart for technical assistance.

B. CAMBER

Charing Cross Hospital,
London, W.C.2.

April 6.

¹ Camber, B., *Nature*, **74**, 1107 (1954).

² Camber, B., *Biochem. J.*, **58**, 11 (1954).

Destruction of Isoniazid in the Presence of Hæmin

It has been shown that hæmin strongly antagonizes the antibacterial action of isoniazid (isonicotinoylhydrazine) on strains of *Mycobacterium tuberculosis* sensitive to this drug¹. These observations have been confirmed and extended². Isoniazid is destroyed in un inoculated media when hæmin is present (see ref. 3, also personal communication from G. P. Youmans). The work to be described was undertaken to find whether the destructive reaction was catalytic or not, to identify the products, and to consider some biological implications.

When isoniazid (10^{-2} *M*) and hæmin (10^{-3} *M*) were shaken with air at 20° (pH 7.5, phosphate or 'tris' buffer) only two substances were formed: diisonicotinoylhydrazine (I) and isonicotinic acid (II). Under these conditions, (I) was not formed from the reaction of isoniazid with (II), as has been claimed by Krüger-Thiemer⁴, but was an intermediate in the formation of (II). These products were isolated and identified. Quantitative paper chromatography showed that after 24 hr. half the isoniazid was unchanged and the rest was converted to equal amounts of (I) and (II). Without hæmin, the reaction took the same course, but more slowly (cf. Bonicke and Reif⁵), and hence the role of hæmin was catalytic. No reaction occurred under nitrogen, even at 85°.

For following the disappearance of very low initial concentrations of isoniazid (10^{-4} *M* or less) only microbiological methods, using *Myc. tuberculosis* as test organism, were delicate enough. In the presence of hæmin (10^{-4} *M*) the concentration of isoniazid was found to fall below 10^{-7} *M*, and here too the hæmin appeared to be acting catalytically.

With a direct-vision spectroscope it was found that hæmin rapidly formed a hæmochromogen (λ_{max} about 560 and 525 $\text{m}\mu$) with an excess of isoniazid, or with less isoniazid when a reducing agent (sodium hyposulphite) was present. The hæmochromogen was purple, and distinct from the orange-red hæmochromogens formed with pyridine, with nicotinic acid hydrazide and with picolinic acid hydrazide. The main band of reduced hæmin as well (580 $\text{m}\mu$) was seen when the isoniazid/hæmin molar ratio fell below 2 to 1. Solutions of this hæmochromogen were stable only in the absence of air. Substance (I), but not (II), slowly formed a hæmochromogen. Many hæmochromogens are more efficient oxidation catalysts than hæmin⁶, and it is possible that this hæmochromogen is the true catalyst.

To study antagonism of the action of isoniazid, some sets of tubes of asparagine glycerol phosphate medium⁷ containing isoniazid (10^{-4} to 10^{-7} *M*) were inoculated with *Myc. tuberculosis* H 37 Rv. When hæmin (10^{-4} *M*) was added immediately, the bacteria grew normally, but if the addition was delayed for one day their growth was slow, and if it was delayed

for two to three days, growth did not occur at all in the lower concentrations of isoniazid. (These results seem to be at variance with those of Fisher¹, who re-initiated growth by hæmin, after long periods of bacteriostasis under apparently similar conditions.) This failure of hæmin to antagonize isoniazid may mean that in three days the drug has reached a site in the bacillus which is inaccessible to hæmin, or is at too low an E_H to be oxidized there, or simply that within three days isoniazid has effected damage of an irreversible nature in the cell.

Relevant portions of this work will be submitted respectively to the *British Journal of Experimental Pathology* and the *Biochemical Journal*. Our thanks are due to Dr. E. F. Hartree for valuable help and suggestions about the spectroscopy.

ROBERT KNOX

Department of Bacteriology,
Guy's Hospital Medical School,
London, S.E.1.

ADRIEN ALBERT
C. W. REES

Department of Medical Chemistry,
Australian National University,
183 Euston Road,
London, N.W.1.
March 23.

¹ Fisher, M. W., *Amer. Rev. Tubercul.*, **69**, 469 and 797 (1954).

² Knox, R., *J. Gen. Microbiol.*, **12**, 191 (1955).

³ Cohn, M. L., Oda, U., Kovitz, C., and Middlebrook, G., *Amer. Rev. Tubercul.*, **70**, 465 (1954).

⁴ Krüger-Thierner, E., *Naturwiss.*, **42**, 47 (1955).

⁵ Bonicke, R., and Reif, W., *Naturwiss.*, **40**, 606 (1953).

⁶ Barron, E. G., Cold Spring Harbor Symp. Quant. Biol., **7**, "Biological Oxidations" (1939).

⁷ Fisher, M. W., *Amer. Rev. Tubercul.*, **66**, 626 (1952).

⁸ Fisher, M. W., *Proc. Soc. Exp. Biol. Med.*, **85**, 538 (1954).

Some Unusual Carotenoids from Two Nudibranch Slugs and a Lamprid Fish

RECENTLY, it has been possible to examine briefly some rare carotenoids of three conspicuously pigmented animals found in the waters off southern California.

Archidoris montereyensis, the sea lemon, is a nudibranch of generally light, slightly dirty yellow colour, with small scattered brown, greyish or black skin-spots and a pair of elongated, finger-like, pointed rhinophore tentacles. Two whole specimens were finely comminuted under acetone in a Waring blender, and the yellow pigment was transferred from the separated solvent into light petroleum by dilution with water. In the partition test with 90 per cent methanol, all the pigment remained epiphasic, that is, in the petroleum, even following treatment with alcoholic potash. Its absorption spectrum was very similar to that of β -carotene. On chromatography, using activated alumina, a minor fraction (about 5 per cent of the total) was eluted with light petroleum containing 5 per cent ether, and appeared to be β -carotene, while the major compound migrated downward when more ether (10–20 per cent) was added to the light petroleum. The absorption spectrum of this major fraction showed maxima at 475 m μ , 450 m μ and an inflexion at about 425 m μ (Fig. 1; Beckman photoelectric spectrophotometer, Model DU), thus differing slightly from β -carotene, from an authentic sample of which it could also be separated chromatographically. Although adsorbed more firmly on alumina than β -carotene, it adhered less strongly than cryptoxanthin (3-hydroxy- β -carotene).

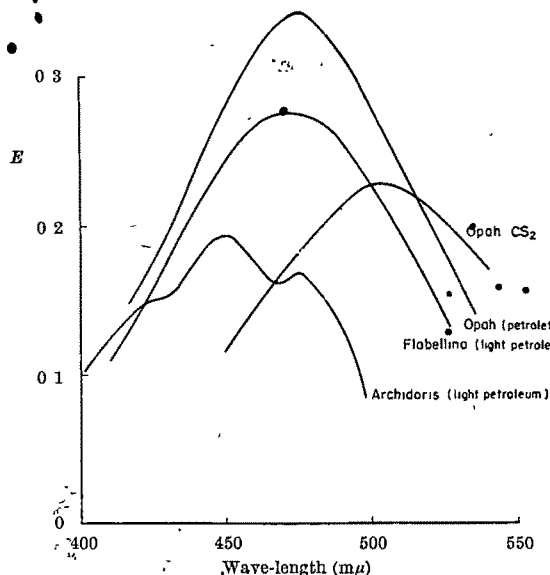


Fig. 1. Absorption spectra of the carotenoid pigments obtained from *Archidoris montereyensis*, *Flabellina iodinea* and *Lampris regius* (the opah or moonfish).

It appears rather similar to an unidentified pigment observed in human blood and milk¹ and in berries of *Lonicera japonica*².

The finding of only hydrocarbon-like (persistently epiphasic) carotenoids in a marine mollusc seems to be almost unique, since these animals are generally characterized by solely or predominantly hypophasic carotenoids³. The deep rose-pink nudibranch, *Hopkinsia rosacea*, yields no carotenes or esterified xanthophylls, but a new xanthophyll with absorption maxima at 497 m μ and 466 m μ in petroleum ether, believed by Strain⁴ to be a ketone.

Flabellina iodinea, the purple sea-slug occurring commonly off La Jolla, has bright purple-violet or purple-blue body skin, orange-red rhinophores and orange-coloured cerata. Two specimens extracted in the same manner as was *Archidoris* yielded a hypophasic carotenoid showing a single, symmetrical absorption maximum at 470–475 m μ in petrol ether (Fig. 1). This type of spectrum suggests that the pigment may be an oxygenated carotenoid, possibly of ketonic nature; it is not, however, of the astaxanthin class, since it exhibited no acidogenic properties after treatment with ethanolic potash. The fact that the purple colour of *Flabellina* changes to red-orange upon treatment with alcohol suggests the presence of a carotenoid protein complex, common in many invertebrates.

Lampris regius. The opah or moonfish, a large oceanic species showing a roundish dorso-ventral profile, with compressed sides, has a brilliant red pigment in the skin, fins, lips and tongue. The specimen examined was taken on a baited hook and long line at a depth of some forty fathoms, approximately four hundred miles west of Magdalena Bay, Baja California. It and other similarly caught specimens contained a few fish and many argonaut cephalopods in the stomach.

The red pigment, recoverable from any of the tissues mentioned above, is somewhat similar to that obtained from *Flabellina*, being persistently non-acidogenic, although exhibiting a symmetrical, single-banded absorption spectrum, with a maximum at 475 m μ in petrol ether, and at 504 m μ in carbon

disulphide (Fig. 1). This is somewhat reminiscent of a neutral xanthophyll recovered by Lederer⁵ from freshwater perch (*Perca fluviatilis*) in that that compound gave a single maximum at 495 m μ in petrol ether and 510 m μ in carbon disulphide.

The opah does not store the crustacean carotenoid, astaxanthin, but may obtain its carotenoid, deriving ultimately from such a source, through its heavy diet of argonauts.

We wish to acknowledge with thanks the generosity of Mr. John A. McGowan for the nudibranchs collected by him, and of Mr. Allan J. Stover and Prof. Carl L. Hubbs for the opah material and information concerning the species. Thanks are also due to the Rockefeller Foundation for financial assistance.

T. W. GOODWIN

Department of Biochemistry,
University of Liverpool.

D. L. Fox

Division of Biochemistry,
Scripps Institution of Oceanography,
University of California,
La Jolla, California.

¹ Kon, S. K., and Mawson, E. H., Spec. Rep. Ser. Med. Res. Coun. Lond., No. 289 (1950).

² Goodwin, T. W., *Biochem. J.*, 51, 458 (1952).

³ Fox, D. L., "Animal Biochromes" (Cambridge University Press, 1953).

⁴ Strain, H. H., *Biol. Bull. Woods Hole*, 97, 206 (1949).

⁵ Lederer, E., *Bull. Soc. Chim. Biol.*, 20, 567 (1938).

Intracellular Distribution of Xanthine Oxidase in the Rat Liver

THE separation of cytoplasmic particles into fractions by differential centrifugation has been extensively used for the study of the distribution of intracellular cell constituents. Some enzymes of oxidative metabolism have been shown to be localized chiefly in the fraction of the liver containing large particles (mitochondria)¹. During the course of an investigation of the xanthine oxidase of the rat liver, we have studied the intracellular distribution of this enzyme, since there seem to be no data in the literature.

The xanthine oxidase activity was measured by the oxygen uptake in a Warburg respirometer using a pyrophosphate buffer, pH 8.6, as previously described². Xanthine dehydrogenase activity was determined in Thunberg vacuum tubes, and the reduction of the dye triphenyltetrazolium chloride measured colorimetrically as formazan³.

Male Wistar white rats were decapitated and livers were rapidly excised, placed in cold 0.25 M sucrose, cut into small pieces and the connective tissue removed by forcing through a gauze. The liver pulp was weighed and homogenized in 9 volumes of ice-cold sucrose. The differential centrifugation was performed according to the procedure of Hogeboom, Schneider and Pallade⁴. All the glassware and the fractions were kept in ice during the operations. The homogenates were centrifuged at 600g for 10 min. The supernatant and the washings were centrifuged at 8,500g for the separation of the mitochondria. The last centrifugation was at 20,000g for 60 min. All the sediments were washed twice with ice-cold 0.25 M sucrose and the washings added to the supernatants. The fractions were checked by staining with Feulgen and Janus green and examined microscopically. Nitrogen was determined in the fractions as a control⁵.

Table 1. INTRACELLULAR DISTRIBUTION OF RAT LIVER XANTHINE OXIDASE

Fractions*	Xanthine oxidase		Xanthine dehydrogenase		Total nitrogen§
	Act-ivity†	Per-centage	Act-ivity‡	Per-centage	
Homogenate	1,077	100	1,270	100	3,295
Nuclei	0	0	0	0	480
Mitochondria	0	0	0	0	769
Submicroscopic particles (microsoma)	0	0	0	0	635
Supernatant (cell sap)	691	64.15	1,325	104.3	1,605

* Experiments carried out on four rats.

† Oxygen (c.mm.) per gm. dry weight/60 min.

‡ Formazan (μ gm.) produced per gm. dry weight/30 min.

§ Nitrogen (μ gm.) per 100 mgm. wet liver.

Table 1 shows the intracellular distribution of xanthine oxidase and dehydrogenase activities in the four fractions studied. The results clearly demonstrate that practically all the enzymic activity is present in the supernatant fluid corresponding to the cell sap containing the soluble proteins of the cell. Little or no activity could be detected for the nuclear, mitochondrial and microsomal fractions. The enzymatic activity of the mixture of the four fractions was 102 per cent of that of the original homogenate. It is interesting to know that uricase was found only in the mitochondria⁶, in contrast to xanthine oxidase, which is absent from this fraction. The decreased percentage obtained for xanthine oxidase in the cell sap as compared with the xanthine dehydrogenase could be explained by the greater stability of the latter as shown by Richert *et al.* in their inhibition studies⁷.

GILBERTO G. VILLELA
EMILIO MITIDIERI
OTTILIA R. AFFONSO

Biochemical Laboratory,
Instituto Oswaldo Cruz,
Rio de Janeiro Brazil.
Jan. 25

¹ Schneider, W. C., and Hogeboom, G. H., *Cancer Res.*, 11, 1 (1951).

² Villela, G. G., and Mitidieri, E., *Nature* [175, 208 (1955)]

³ Villela, G. G., *Rev. Bras. Biol.*, 1, 455 (1954).

⁴ Hogeboom, G. H., Schneider, W. C., and Pallade, G. E., *J. Biol. Chem.*, 172, 619 (1948).

⁵ Lanni, F., Dillon, M. L., and Beard, J. N., *Proc. Soc. Exp. Biol. Med.*, 74, 4 (1950).

⁶ Schein, A. H., Podber, E., and Novikoff, A. B., *Fed. Proc.*, 9, 224 (1950).

⁷ Richert, D. A., Vande-linde, R., and Westerfeld, W. W., *J. Biol. Chem.*, 18, 261 (1950).

Actively Acquired Tolerance to a Mouse Tumour

THE 6C3HED lymphosarcoma¹ is an ascites tumour of mice, apparently of uniform antigenic properties, containing a near-tetraploid mode of chromosomes². It is invariably lethal to C3H mice and to F₁ hybrids between the original strain and A or DBA mice. The tumour consistently regresses in mice of other strains. Since Billingham, Brent and Medawar³ have recently demonstrated that mice can be rendered susceptible to skin homografts by the injection of embryos *in utero* with donor-strain tissues, the same method has been applied to the abrogation of resistance of a strain of Swiss mice to the 6C3HED tumour.

Embryos of the CR (Institute for Cancer Research, Philadelphia, Pa.) strain of Swiss mice were injected *in utero* on the sixteenth to seventeenth day of

gestation with one of the following: blood of *C3H* mice, blood of F_1 generation *C3H* $\times$ *DBA* mice, or a suspension of *6C3HED* ascites tumour cells. Trypan blue was incorporated into the inocula so that, following birth, mice which had actually been injected *in-utero* could be distinguished easily by their blue coloration. Mice which received as embryos the blood of either *C3H* or F_1 (*C3H* $\times$ *DBA*) mice were implanted at the age of six to eight weeks intraperitoneally with cells of the *6C3HED* ascites tumour. All injected mice in both groups developed ascites, which progressively increased in volume. Aliquots of ascites fluids, which contained large numbers of tumour cells, were subinoculated into groups of adult *ICR* mice. The second passage of ascites resulted in the deaths of some of the inoculated mice, and the two sublines have been maintained without difficulty in *ICR* mice as ascites tumours for twenty-seven passages up to date.

ICR mice injected in the embryonic stage directly with tumour cells (*vide supra*) developed palpable tumours, always in the subcutaneous tissue of the neck, on the tenth to twenty-fifth day after birth. These tumours were removed seven to ten days after they were first detected, and made into a suspension which was implanted intraperitoneally into adult *ICR* mice. Ascites developed in all these mice, and half the animals died ten to twelve days after implantation of the tumour. This subline has been maintained for thirty passages up to date.

The three derivative sublines of the *6C3HED* tumour lost completely the host specificity of the original tumour. All strains of mice so far tested have been found equally susceptible to the lethal effect of the tumour, implanted either intraperitoneally or subcutaneously. The cancer cells of the derivative lines are morphologically very similar to those of the original tumour, although the cellular volumes of the latter are somewhat less. Marked differences were observed, however, in the chromosome ploidy of the tumours. The study of chromosome number distribution for the main line of *6C3HED* tumour (grown in *C3H* mice) indicated modal values at or near diploid with very little variability². Cells of the three derivative Swiss mice-adapted tumours are characterized by greater polyploidy of the chromosome number, with the hyperdiploid mode prevailing.

Infection of the tumours with viral agents revealed the most striking differences in biological characteristics between the main line and the derivative tumours. Mengo and Bunyamwera viruses^{4,5} failed to grow in the tumour tissue and to exert an oncolytic effect upon the original *6C3HED* tumour, although they killed the *C3H* host. In contrast, the same viruses multiplied in all three Swiss mouse-adapted sublines and destroyed the tumour cells.

The results of this investigation indicate that the method of enhancing susceptibility to skin homografts advanced by Billingham, Brent and Medawar⁶ can be extended to the field of tumour homografts. The direct inoculation of the embryo with tumour cells, resulting in abrogation of resistance and acquisition of tolerance on the part of the recipient after birth, offers possibilities for further exploration. This work also shows that an ascites tumour transplanted to a tolerant mouse may undergo a profound change of antigenic specificity. The mechanism underlying this change may be selective. According to Billingham, Brent and Medawar (personal communication), the tolerance produced by whole blood in embryos which

cannot be injected intravenously is relatively feeble; a weak residual immunity could well exert a selective action on what is essentially a population of isolated tumour cells.

H. KOPROWSKI

Viral and Rickettsial Section,
American Cyanamid Co.,
Research Division,
Pearl River, N.Y.
April 19.

¹ Gardner, W. U., Kirschbaum, A., and Strong, L. C., *Arch. Path.*, 29, 1 (1940).

² Levan, A., and Hauschka, T. S., *J. Nat. Cancer Inst.*, 14, 1 (1953).

³ Billingham, R. E., Brent, L., and Medawar, P. B., *Nature*, 172, 603 (1953).

⁴ Koprowska, I., and Koprowski, H., *Cancer Res.*, 13, 651 (1953).

⁵ Koprowska, I., and Koprowski, H., *J. Nat. Cancer Inst.*, 14, 627 (1953).

⁶ Billingham, R. E., Brent, L., and Medawar, P. B., *Ann. N.Y. Acad. Sci.*, 59, 409 (1955).

Parasitological Significance of Bovine Grazing Behaviour

THE bovine habit of not eating grass growing in the vicinity of bovine faeces has been the subject of occasional speculative writing, which has discussed the supposed value of such behaviour in protecting the animal from parasitism. A recent study of the free-living stages of the cattle lungworm¹ suggested that, in order to ingest the larvæ, the bovine host had to ingest bovine faeces. An investigation into certain aspects of grazing behaviour appeared to be warranted, and as a first step observations were made to determine whether by virtue of its apparently selective pattern of grazing the bovine did indeed ingest fewer larvæ than it would if its grazing were entirely at random.

It was found that, by following and observing grazing cattle, it was possible to see with considerable accuracy from where grass was being taken. Not only was the freshly bitten grass of a slightly different colour, but also the spot from which each mouthful had been pulled could be discerned by the displacement and compression of the grass. Young cattle grazing on a paddock known to be heavily infected with *Dictyocaulus viviparus* were followed in this manner, and samples of herbage were taken by cutting small pinches from immediately beside the bitten spots. At the same time, random samples were taken from the paddock by a standard procedure.

Comparison of the concentration of lungworm larvæ in samples taken by these two methods showed that in twenty-five cases out of twenty-six the herbage collected after the manner of the animals contained fewer larvæ than the random samples. The

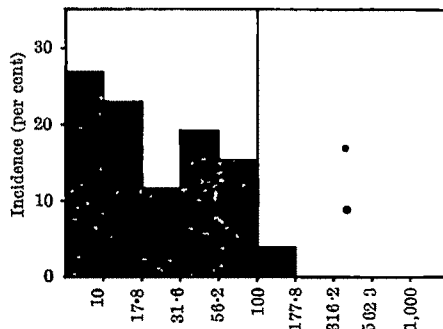


Fig. 1. Larvæ in grazing samples as a percentage of larvæ in random samples

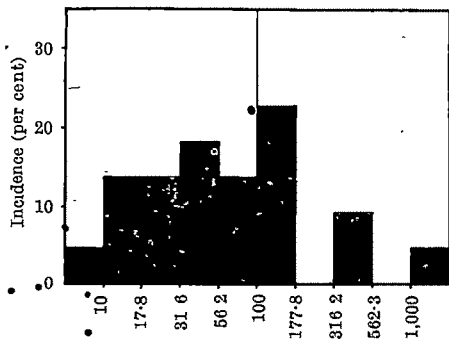


Fig. 2. Larvae in short grass as a percentage of larvae in random samples

frequency distribution of the larval concentration in these 'grazing samples' expressed as a percentage of the appropriate random samples is shown in Fig. 1, from which it will be seen that bovine grazing is indeed highly selective from a parasitological point of view.

Concurrently with these observations and using the same paddock, a comparison was made between the concentration of larvae in samples taken from the areas of short grass which had evidently relatively recently been grazed and the random samples. Fig. 2 shows the frequency distribution of the larval concentration in these samples of short grass expressed as a percentage of the random samples. While there is a tendency for the short grass to contain fewer larvae than the random samples, it is clear from a comparison of Figs. 1 and 2 that the success of the animal in avoiding infection depends on something more than its ability to distinguish between short grass and the rank tussocks of herbage growing around pats of faeces.

J. F. MICHEL

Veterinary Laboratory
(Ministry of Agriculture),
Weybridge.
Jan. 31.

¹ Michel, J. F., and Rose, J. H., *J. Comp. Path.*, 64, 195 (1954).

Classification of Geckos

I HAVE recently put forward proposals for the classification of geckos¹. In this paper the view was advanced that the amphiœelous condition of the vertebræ characteristic of the majority of geckos is secondary, derived from the proœelous condition found in all other recent lizards. Of the three families of geckos recognized the two which conserve primitive ophthalmological characters, Eublepharidae and Sphaerodactylidae, are proœelous. I therefore supposed that primitive geckos were proœelous and that the Gekkonidae s.s., which show the most complete conversion to secretive and nocturnal habits, are secondarily amphiœelous. More or less implicit in this view was the idea that the proœelous condition was early fixed in the definitive lizard stock.

It is now becoming increasingly clear that there was in the Triassic a considerable radiation of amphiœelous definitive lizards. Some Middle Triassic forms are discussed by Kuhn-Schneider², and Miss Pamela Lamplugh Robinson, of University College, London, has shown me some beautifully preserved material of an Upper Triassic lizard fauna in Britain. All these are amphiœelous; it is therefore clear that

definitive lizards appeared long before the 'fixation' of the proœelous condition. Miss Lamplugh Robinson points out that the change from the amphiœelous to the proœelous condition is so trivial morphologically that there is no difficulty about supposing that it has occurred several times. I wish, therefore, to withdraw my earlier suggestion in favour of the more generally held view that the amphiœelous geckos preserve a primitive condition of the vertebral column. The paired condition of the atlas neural arch likewise appears to be a primitive character.

A visit to the British Museum (Natural History) has enabled me to extend this study. A detailed report is in preparation; some conclusions are here briefly noted.

Osteological study confirms the position of *Aeluroscalabates* in the Eublepharidae. Examination of the feet strongly suggests that this genus is derived from a pad-bearing arboreal stock. It thus seems likely that the entire group of geckos has originated from arboreal ancestors. I incline to regard *Aeluroscalabates* as the most archaic surviving genus of geckos; its occurrence in Borneo is noteworthy³. The Eublepharidae have proœelous vertebræ but retain the paired condition of the atlas neural arch. The Sphaerodactylidae have proœelous vertebræ and united atlas neural arch. The Gekkonidae retain amphiœelous vertebræ and the majority retain the paired condition of the atlas neural arch; in a number of scattered genera, however, the arch is united.

Better material of the Australian *Rhynchoedura ornata* makes it clear that it belongs to the Gekkoninae. Material of the New Caledonian *Eurydactylus vieillardii* shows that it belongs to the Diplodactylinae. The six Australian, three New Caledonian and two New Zealand diplodactyline genera form a well-defined tribe within the subfamily on osteological characters.

Quedenfeldtia is placed in the Diplodactylinae on osteological grounds. The following genera are allocated to the Gekkoninae on pupil-shape: *Briba*, *Ceramodactylus*, *Drovidogekko*, *Homonota* and *Perochirus*. On characters of osteology and squamation, *Ancylodactylus*, *Cnemaspis* and *Pristurus* appear to be related to *Cyrtodactylus* and are therefore placed in the Gekkoninae.

GARTH UNDERWOOD

Department of Zoology,
University College of the West Indies,
Mona, Jamaica.
Jan. 10.

¹ Underwood, G., *Proc. Zool. Soc. Lond.*, 124, 469 (1954).

² Kuhn-Schneider, E., *Encycavour*, 13, 213 (1954).

³ Darlington, P. J., *Quart. Rev. Biol.*, 23, 1 and 105 (1948).

Scale-eating Habits of African Cichlid Fishes

IN a recent communication, Marlier and Leleup¹ have described how the Tanganyikan Cichlid fishes of the genus *Plecodus* deliberately attack other fishes and bite off the scales, which are their sole or main means of subsistence. These authors mention the specialized, large, curved teeth which enable the species of *Plecodus* to feed in this way and remark on the apparent uniqueness of the habit.

Although this seems to be the only observation of fishes engaged in such a habit, a similar diet has been recorded for Nyasan Cichlids of the genus *Corematodus*. During the 1939 Fishery Survey of Lake Nyasa², six specimens each of *C. shiranus*

Boulenger and *C. taeniatus* Trewavas were examined and the stomachs and intestines were found to be full of minute fish scales, matching in size and structure those that densely coat the caudal fin in the Nyasan Tilapias and other Cichlid fishes. The dentition of *C. shiranus* is figured by Boulenger³, who describes it as consisting of "extremely broad bands of innumerable minute club-shaped teeth with compressed oblique crowns". Trewavas⁴ describes how the caudal fin of a *Tilapia* can be held between the upper and lower file-like tooth-bands of *Corematodus* and only pulled free at the cost of losing some scales.

During the course of work on a rocky shore of Lake Nyasa, one of us (G. F.) has recently collected five specimens of the little-known endemic Cichlid *Genyochromis mento* Trewavas. The guts of all five contained a number of relatively enormous fish scales, evidently derived from Cyprinid fishes of the genus *Labeo*. These scales were partly digested and apparently constitute the main food of the species, as in all cases they composed the bulk of the gut contents, sometimes to the exclusion of all else. In one specimen they were accompanied by a few slender fin-rays but by no other bones, and in another by a very small quantity of filamentous algae.

The dentition of *G. mento*, figured by Trewavas⁵, is quite different from that of either *Corematodus* or *Plecodus*. The lower jaw is stout and prominent. Both jaws bear bands of teeth, of which all but those of the outer row are tricuspid; the outer are bicuspid. If the outer teeth of the lower jaw are inserted under the edge of a scale of *Labeo* the scale is easily removed.

Genyochromis mento is related to *Pseudotropheus*, *Petrotilapia* and *Cyathochromis*, the members of which graze on epiphytic and epilithic algae. Baerends and Baerends-van Roon⁶ describe in *Tilapia natalensis* "a peculiar way of eating algae from substrates. It opens the mouth widely, presses it against the substrate and closes it while pressing". This is very similar to the account by Marlier and Leleup of the action of *Plecodus* in biting scales from its victims. One of us (P. H. G.) has noticed in a Cyprinid, *Labeo*, of Lake Victoria, behaviour that suggests a possible step by which a grazer on algae may become a scale eater. The *Labeo* was seen repeatedly to graze on the sessile rotifers growing on the flanks of a *Polypterus* kept with it in an aquarium. *Labeo* has toothless, sharp-edged jaws; but most Cichlid grazers on algae, including those related to *Genyochromis*, have bands of movable teeth. The teeth of *Genyochromis* are relatively firmly fixed. The same jaw action would shave the surface where the teeth are movable and remove scales where the teeth are fixed, especially with a prominent lower jaw. These rather scattered observations suggest how the scale-eating habit in *Genyochromis* might evolve from the grazing, with a change from movable to fixed teeth.

The three genera that have adopted the scale-eating habit are not very closely related within the family Cichlidae and have achieved the same end by dissimilar means.

Except that it seems to be related to *Perissodus*, a genus that also has a specialized dentition, the ancestry of *Plecodus* is obscure; but it does not necessarily follow that because some individuals will take a bait the species of its ancestor is predominantly voracious. Yet in this case scale-eating may be a modified predation, as it almost certainly is in *Corematodus*.

The work on *Genyochromis* is part of a study now in progress of the ecology of some littoral zone fishes in Lake Nyasa.

G. FRYER

Joint Fisheries Research Organization,
Nkata Bay, Nyasaland.

P. H. GREENWOOD

East African Fisheries Research Organization,
Jinja, Uganda.

E. TREWAVAS

British Museum (Natural History),
London, S.W.7.

April 14.

¹ Marlier, G., and Leleup, N., *Nature*, 174, 935 (1954).

² Bertram, G. K. Ricardo, Borley, H. J. H., and Trewavas, E., Report on the Fish and Fisheries of Lake Nyasa, pp. 60-61 (1924).

³ Boulenger, G. A., "Cat. Fresh-Water Fishes Africa", 3, 494 (1915).

⁴ Trewavas, E., *Nature*, 160, 120 (1947).

⁵ Trewavas, E., *Ann. Mag. Nat. Hist.*, (10), 16, 65 (1935).

⁶ Baerends, G. P., and Baerends-van Roon, J. M., *Behaviour*, Supp. 1, 30 (1950).

Permanent Preparations of Nematodes

WHILE working on the micro-fauna of Whitstable, I found that mounting media containing lactic acid were unsuitable for making permanent preparations of nematodes; they cloud in this medium on keeping. An attempt was therefore made to prepare mountants based on creosote, which is the outstanding clearing agent for these animals. Of these mountants the most successful is a solution of 'Perspex' in creosote, although solutions of methyl cellulose and ethyl cellulose in this solvent were also valuable.

The mountant is prepared by heating creosote on a water-bath and adding 'Perspex' powder until a solution of the required viscosity is obtained.

The method of mounting nematodes in this medium is as follows: extend, kill and fix in hot 70 per cent alcohol (alternatively, extend and kill by warming up in sea water; fix in formol-acetic mixture); wash in 70 per cent alcohol; drain; clear in creosote; mount in creosote/'Perspex' mountant.

E. J. PERKINS

Department of Zoology,

Queen Mary College

(University of London),

Mile End Road,

London, E.1.

March 1.

Adaptability of Wheat Varieties to Acid Soils

It is common experience that certain varieties of wheat can tolerate a considerable degree of acidity in soils, while other varieties, although botanically similar, are very sensitive to this condition. As work in recent years has shown that the soil acidity complex can be resolved into a number of separate factors¹, it was decided to investigate the importance of two of these factors—aluminium and manganese toxicity—in relation to the acidity tolerance of wheat varieties.

Four varieties, known to show a differential response towards soil acidity, were selected for special study. These were grown in sand culture in the open, the general technique being similar to that of Hewitt¹. The varieties were: (1) Atle, which is extremely sensitive, (2) Karn II, which is moderately sensitive, (3) Progress, which is moderately tolerant, and (4) April Red, which is comparatively immune, to soil

Table 1

Parts per million	Mn I 27	Mn II 55	Mn III 82	Mn VI 110	Mn V 137	Al I 108	Al II 162	Al III 216	Al IV 270
Atle	Slight	M. severe	Severe	Severe	Severe	Slight	V. severe	V. severe	V. severe
Karn II	Slight	Slight	M. severe	M. severe	M. severe	Severe	V. severe	V. severe	V. severe
Progress	Slight	Slight	M. severe	M. severe	M. severe	Severe	V. severe	V. severe	V. severe
April Red	Unaffected	Unaffected	V. slight	Slight	Slight	Slight	Severe	Severe	Severe

acidity. Table 1 shows the reaction of the varieties as indicated by the severity of the symptoms on the foliage.

The yields of dry matter expressed as a percentage of control are given in Table 2.

Table 2

Treatment	Atle	Karn II	Progress	April Red
Control				
(Mn at 0.55 p.p.m.)	100.00	100.00	100.00	100.00
Mn at 27 p.p.m.	90.51	90.51	82.00	117.90
" 55 "	56.19	85.04	82.34	114.76
" 82 "	50.77	68.79	65.02	100.81
" 110 "	38.48	41.30	59.52	76.74
" 137 "	17.98	33.29	54.47	50.96
Al at 108 p.p.m.	39.93	21.12	19.84	42.16
" 162 "	11.02	4.72	8.94	17.49
" 216 "	5.96	4.15	5.62	15.87
" 270 "	7.77	4.15	7.97	11.63

These results show that varieties may behave somewhat differently towards the individual factors which constitute the acidity complex of the soil—some varieties being rather tolerant of excess aluminium whereas other varieties were more tolerant of high concentrations of manganese.

It will be observed that the variety April Red, noted for its tolerance of acidity, is comparatively resistant to both manganese and aluminium toxicity. This may be correlated with its high requirement of manganese, which is indicated by the positive response obtained from applications of up to 82 p.p.m. of this element.

Further experiments with other cereals indicate that these also show a differential reaction to these factors of the soil acidity complex.

A full account of this work will appear shortly (*J. Dept. Agric., Dublin*).

M. NEENAN

Soil Laboratory,
Department of Agriculture,
Johnstown Castle Agricultural College,
Wexford. March 4.

¹ Hewitt, E. J., Long Ashton Res. Sta. Ann. Rep. 1946 (1948).

Disomic Addition of Rye Chromosome II to Wheat

It has been suggested¹ that the most satisfactory way of transferring agriculturally advantageous characters to *Triticum vulgare* ($2n = 42$), bread wheat, from diploid species of related genera may be by the production of alien chromosome disomic additions or substitutions. During work concerned with the production of rye (*Secale cereale*) chromosome additions in *T. vulgare*, a 28-chromosome plant, which arose parthenogenetically in the progeny of the octoploid amphidiploid *T. vulgare* var. Holdfast $\times$ *S. cereale* var. King II, was crossed with the *T. vulgare* parent. A single F_1 plant was obtained, and this had 49 chromosomes which formed 21 bivalents and 7 univalents at meiosis, that is, it had the full *T. vulgare* complement plus the rye haploid

complement of chromosomes. Our usual procedure is to make a further back-cross of such 49-chromosome plants to extract the 43-chromosome, monosomic addition, types which form the most frequent class in the aneuploid range obtained in this way. Afterwards, disomic addition types have been obtained in the progeny of selfed monosomic addition plants, and this work will be described elsewhere. However, this 49-chromosome F_1 plant was also allowed to self, and among the progeny obtained in this way was a plant with 44 chromosomes in which the two added rye chromosomes were identical. This may be recognized from the morphology of the chromosomes (Fig. 1), both of which had a sub-median centromere and a pronounced secondary constriction giving rise to a clear satellite. There is only one pair of chromosomes with this morphology in *S. cereale* (Fig. 2). The equivalence of the chromosomes is further proved by the occasional formation of 22 bivalents at meiosis. This plant had, therefore, the full complement of *T. vulgare* chromosomes plus a disomic rye chromosome.

Phenotypically the disomic plant differed from *T. vulgare* var. Holdfast in having: (1) very slight hairiness of the peduncle ('hairy neck'); (2) a narrow and tapering ear; (3) long, straight lemma points, especially in the upper part of the ear; (4) red grain.

O'Mara² has reported that 'hairy neck' was caused by *Secale* chromosome I, which has a subterminal centromere and a pronounced median secondary constriction; this chromosome is clearly distinct from the one under discussion, which we shall designate II, following O'Mara's precedent. The morphology and dimensions of chromosome II are identical with those of the chromosome labelled s^1 by Levan³ in mitotic studies. However, the expression of the 'hairy neck' character in disomic addition II was less pronounced than that in I, and the two addition types also differ in other ear characters. The two chromosomes have distinctive phenotypic effects, therefore. Disomic addition II also appears very similar to descriptions of a 'hairy neck' selection, in wheat-rye derivatives, reported by Taylor⁴ to have 44 chromosomes. It appears, therefore, that factors on both chromosomes I and II, at least, must be responsible for the 'hairy neck' character of *Secale*. Other evidence of the effects of chromosome II was obtained by Takagi⁵, who found a rye plant in which it was trisomic to be dwarf-like, and "delicate with slender stems and leaves".

From Table 1 it may be seen that chromosome II paired at meiosis in the disomic addition plant in only 9.7 per cent of pollen mother cells (Fig. 3). Although some failure of pairing of the disomic addition chromosomes has been reported previously^{1,2}

Table 1. FREQUENCIES OF TYPES OF PAIRING AT M_1 IN POLLEN MOTHER CELLS IN DISOMIC ADDITION II (BASED ON 62 CELLS)

Pairing types	22II	21II.21	20II.41	19II.6I
No. of cells	6	52 (83.7%)	3 (4.8%)	1 (1.8%)



Fig. 1. Photomicrograph of first anaphase of meiosis in an anther squash of a disomic addition II plant, showing *Secale* chromosome II as two longitudinally dividing univalents. $\times 1,350$

Fig. 2. Photomicrograph of metaphase of mitosis in a root tip of *S. cereale* (after pre-treatment with α -bromonaphthalene) showing chromosome II. $\times 1,350$

Fig. 3. Photomicrograph of first metaphase of meiosis in an anther squash of a disomic addition II plant, showing 21 bivalents and *Secale* chromosome II represented as 2 univalents. $\times 1,350$

it does not seem to have been of this magnitude, nor was there in the present case as much asynapsis of the wheat chromosomes as has been reported previously². Since in the colchicine-induced 56-chromosome amphidiploids, from which this rye chromosome was obtained, there was regular pairing to form 28 bivalents in 40 per cent of the meiotic first metaphases examined, the pairing failure in disomic addition II cannot be due to the complete homozygosity of the chromosomes of the outbreeding rye species. The implication must be that the genetic control of pairing in wheat is not fully effective for a single pair of rye chromosomes, and that these chromosomes possess no internal control which will cause regular pairing in the wheat genotypic background.

The disomic addition II plant was about as fertile as plants of the *T. vulgare* parent from which it was derived grown in similar greenhouse conditions. However, its meiotic irregularity was apparent from the chromosome number segregations in its progeny (Table 2).

It is apparent that, so far as *Secale* chromosome II is concerned, the disomic addition line is too unstable to be of value in plant breeding, and to obtain stability it may be necessary to resort to the substitution line in which a wheat chromosome pair would be replaced by the alien pair. However, we do not yet know whether all rye disomic addition

plants, and analogous addition types using chromosomes of the diploid species of other genera, behave in this way.

We thank Dr. G. D. H. Bell, director of this Institute, for his interest and encouragement.

V. CHAPMAN
RALPH RILEY

Plant Breeding Institute,
Cambridge. April 19.

¹ O'Mara, J. G., *Genetics*, 25, 401 (1940).

² O'Mara, J. G., *Cytologia*, 16, 225 (1951).

³ Levan, A., *Hereditas*, 28, 177 (1942).

⁴ Taylor, J. W., *J. Agric. Res.*, 48, 603 (1934).

⁵ Takagi, F., *Cytologia*, 6, 496 (1935).

"The Sources of Eddington's Philosophy"

THERE is one passage in Dr. Martin Johnson's notice¹ of my recent Eddington Memorial Lecture which I fear may cause misunderstanding. Referring to my relations with Eddington, he writes: "The old instinctive antagonism is there".

In no sense was there ever any "instinctive antagonism" between Eddington and me. For the man I had the warmest regard—a feeling which I have reason to believe was reciprocated. With his outlook I had such fundamental sympathy as to have considerable confidence in my perception of what had perverted it. I could not feel that confidence concerning a view to which I was instinctively antagonistic.

HERBERT DINGLE

University College,
London.
May 13.

¹ *Nature*, 175, 788 (1955).

Table 2. CHROMOSOME NUMBERS OF 56 PLANTS IN THE PROGENY OF DISOMIC ADDITION II

Chromosome number	22*	42	43	44	45
No. of plants	1	26	23	4	1

*Presumably *T. vulgare* haploid plus rye II.

FORTHCOMING EVENTS

Monday, June 20

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. D. le Vay and Dr. J. F. Tait: "The General Adaptation Syndrome—the Concept and Its Implication".

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 8.15 p.m.—Dr. Roger M. Barker: "Psychological Ecology of an American Town".

Wednesday, June 22

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. H. C. W. Stockbridge: "Psychology and Equipment"; Mr. D. H. Holding: "Some Relationships between Displays and Controls in Different Planes".

Wednesday, June 22—Saturday, June 25

INSTITUTE OF PHYSICS, NON-DESTRUCTIVE TESTING GROUP (at the Royal Technical College, George Street, Glasgow, C.1)—Summer Meeting.

Thursday, June 23

At 9 a.m.—Annual General Meeting.

Thursday, June 23—Friday, June 24

SOCIETY FOR THE STUDY OF FERTILITY (in the Anatomy Lecture Theatre, The Medical School, Hospitals Centre, Birmingham), at 10 a.m. daily—Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYST, Senior Scientific Officer grade (with high qualifications and appropriate experience) to conduct, under the immediate direction of the Principal Scientific Officer, routine analytical work, having particular reference to polluted surface waters, sewage and trade effluents—The Chief Pollution and Fisheries Officer, Trent River Board Laboratories, Meadow Lane, Nottingham (June 23).

LECTURER IN BACTERIOLOGY—The Secretary, The University, Aberdeen (June 23).

ASSISTANT LECTURER (with special qualifications in inorganic or physical chemistry) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (June 25).

SENIOR LECTURER, LECTURER AND ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS, to work and carry out research in one or more of the following fields: nuclear physics, theoretical physics and radio-astronomy—The Registrar, The University, Manchester (June 25).

ASSISTANT IN THE DEPARTMENT OF ZOOLOGY at St. Salvator's College, St. Andrews—Joint Clerk to the University Court, College Gate, St. Andrews (June 30).

ASSISTANT IN PHYSIOLOGY—Joint Clerk to the University Court, Queen's College, Dundee (June 30).

ASSISTANT LECTURER IN AGRICULTURAL ENGINEERING AND FARM MECHANIZATION at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

DEMONSTRATOR (with a good honours degree in psychology) IN THE DEPARTMENT OF PSYCHOLOGY—The Registrar, The University, Bristol (June 30).

MYCOLOGIST (Scientific Officer grade), to work in the Plant Pathology Department on the spread of crop diseases—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 30).

RESEARCH ASSISTANT IN THE DEPARTMENT OF GEOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 30).

SENIOR LECTURER or LECTURER (Grade I) (with special interests in physical chemistry) IN CHEMISTRY; LECTURERS (2) (Grade II) or ASSISTANT LECTURER IN CHEMISTRY; SENIOR LECTURER or LECTURER (Grade I) IN PHYSICS, and a LECTURER (Grade I) IN ZOOLOGY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

SENIOR SCIENTIFIC OFFICER (with a degree of high standard in physics or engineering, experience in measurement techniques based on optical or precision mechanical methods, and preferably with some experience in the design of optical components) IN THE DEPARTMENT OF SUPPLY, Weapons Research Establishment, Salisbury, South Australia, to undertake investigations into measurement techniques based on optical, precision mechanical and electronic methods applicable to the determination of the performance of guided missiles—The Senior Representative (AP.29), Department of Supply, Australia House, Strand, London, W.C.2 (June 30).

ASSISTANT LECTURER IN PSYCHOLOGY—The Registrar, The University, Manchester (July 1).

RESEARCH STUDENTS (with the degree of Bachelor or Master of a British University other than Manchester) IN SCIENCE—The Registrar, The University, Manchester 18 (July 1).

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics) at the National Physical Laboratory, for work on photometry

and colorimetry with particular emphasis on physical methods and problems connected with the primary and secondary standards of light and the colour temperature scale—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.178/5A (July 2).

HEAD (Principal Scientific Officer grade) OF THE GRASS AND DAIRY HUSBANDRY DEPARTMENT—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (July 4).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Leeds 2 (July 4).

LECTURER IN AGRICULTURAL BOTANY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 6).

LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (July 6).

LECTURER (preferably applicant who has worked on the dynamics of continuous media) IN THE DEPARTMENT OF MATHEMATICS—The Secretary, University College, Gower Street, London, W.C.1 (July 9).

PROFESSOR OF BOTANY at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (July 15).

LECTURER (with considerable experience in hospital biochemistry and in teaching) IN CLINICAL CHEMISTRY—The Secretary, The University, Edinburgh (July 16).

SENIOR LECTURER (veterinary surgeon with tropical experience) IN EPIZOOTIOLOGY—The Secretary, The University, Edinburgh (July 22).

LECTURER (with industrial and research experience) IN ENGINEERING—The Secretary, The University, Edinburgh (August 1).

PROFESSOR OF EXPERIMENTAL PHYSICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 10).

PLANT PATHOLOGIST (with an honours degree of a recognized university or equivalent qualifications, together with considerable research experience in plant pathology, and preferably with a specialist knowledge of mildew diseases) at the Rubber Research Institute of Ceylon, to work mainly on *Oidium* and *Phytophthora* leaf diseases of rubber in Ceylon—The Director, Rubber Research Institute of Ceylon, Agalawatta, Ceylon, also a copy to the Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.V.7 (August 15).

PROFESSOR OF EDUCATION at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 31).

ASSISTANT, Grade A (with graduate or equivalent qualifications), to teach mathematics—The Clerk to the Governors, Luton and South Bedfordshire College for Further Education, 63/69 Guildford Street, Luton, Beds.

ASSISTANT, Grade B (with special qualifications in organic chemistry and experience in semi-micro inorganic analysis) IN THE DEPARTMENT OF CHEMISTRY, at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

ASSISTANT TECHNICAL SECRETARY (with a general science degree or equivalent qualification, and preferably with experience in metallurgical analysis, metallography or physical testing) IN THE METALLURGY DIVISION, British Iron and Steel Research Association, London—The Personnel Officer, B.I.S.R.A., 11 Park Lane, London, W.1, quoting "Assistant Technical Secretary".

CHEMIST (with at least a second-class honours degree) for fundamental research on the mechanism of dyeing, particularly on the new man-made fibres; and a CHEMIST (with at least a second-class honours degree and a leaning towards organic chemistry), for research, initially fundamental, on the chemical finishing of textiles, particularly proofings and finishes of a durable nature—Dr. F. C. Toy, Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.

HEAD OF THE DEPARTMENT OF MATHEMATICS, and an ASSISTANT PROFESSOR IN THE DEPARTMENT OF MATHEMATICS—The University of New Brunswick, Fredericton, N.B., Canada.

LECTURER (with a good honours degree in electrical engineering or equivalent qualifications, and with industrial experience in electronics or telecommunications) IN ELECTRICAL ENGINEERING—The Principal, North-West Kent College of Technology, Miskin Road, Dartford, Kent.

LECTURER or ASSISTANT LECTURER (with special qualifications in organic chemistry) IN PHARMACEUTICAL CHEMISTRY—The Registrar, The University, Nottingham.

RESEARCH DEMONSTRATORS (2) IN PHYSICS, and a RESEARCH ASSISTANT IN THE DEPARTMENT OF PHYSICS, for work on ultrasonics—The Registrar, University College, Leicester.

SCIENTIFIC ASSISTANT (with a knowledge of at least two European languages and training or experience in agricultural (especially soil) science) for work in a scientific information service involving abstracting and indexing—The Director, Commonwealth Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER at the Merlewood Research Station, Grange-over-Sands, to initiate a small section for work on the biology of soil fungi and bacteria—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1.

SCIENTISTS and SCIENTIFIC TECHNICAL OFFICERS IN THE NATIONAL COAL BOARD LABORATORIES in the Warwickshire area—The Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Wores.

SENIOR RESEARCH FELLOWS (with a good honours degree in chemistry (or in one case, metallurgy) of a British university, and preferably with academic or industrial research experience in inorganic or physical chemistry) IN THE DEPARTMENT OF APPLIED SCIENCE, Wolverhampton and Staffordshire Technical College—The Clerk to the Governors, Education Offices, North Street, Wolverhampton.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

- Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 934, Vol. 247 (19 April 1955): The Scattering of a Scalar Wave by a Semi-infinite Rod of Circular Cross Section. By D. S. Jones. Pp. 499-528. 9s. No. 935, Vol. 247 (19 April 1955): On Certain Integrals of Lipschitz-Hankel Type Involving Products of Bessel Functions. By G. Eason, B. Noble and I. N. Sneddon. Pp. 529-551. 7s. (London: Royal Society, 1955.) [254]
- Department of Scientific and Industrial Research. Report of the Road Research Board, with the Report of the Director of Road Research for the year 1954. Pp. vi+82+4 plates. (London: H.M. Stationery Office, 1955.) 4s. net. [254]
- Department of Scientific and Industrial Research. Report of the Hydraulics Research Board, with the Report of the Director of Hydraulics Research for the year 1954. Pp. vi+52+11 plates. (London: H.M. Stationery Office, 1955.) 5s. net. [254]
- Royal Institute of Chemistry. Lectures, Monographs and Reports, 1955. No. 2: Chemistry, Biochemistry and Isotopic Tracer Technique. By George Popjak. Pp. iv+59. (London: Royal Institute of Chemistry, 1955.) [254]
- Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1953-54. Northern Nigeria. Pp. 21. (London: Empire Cotton Growing Corporation, 1955.) 9d. [254]
- Annual Report and Year Book of the Association of British Pharmaceutical Industry, 1954-55. Pp. 35. (London: Association of British Pharmaceutical Industry, 1955.) [254]
- Proceedings of the Thirtieth International Congress of Americanists, held at Cambridge, 18-23 August 1952. Pp. xxx + 250 (24 plates). (London: Royal Anthropological Institute.) [254]
- Local Accessibility: the Hinterlands of Towns and Other Centres as Determined by an Analysis of Bus Services. Compiled by the Ministry of Housing and Local Government from information supplied by the bus operators and the Ministry of Transport and Civil Aviation. Sheet 1: Scotland and N. England. Sheet 2: The Remainder of England and Wales. (Cheshington, Surrey: Director General of the Ordnance Survey, 1955.) 6s. per sheet. [254]
- Stammering: Its Cause and Cure. (A supplement to "Stammer is Not Nerves".) By H. V. Hemery. Pp. iv+17. (London: School for Functional Speech Disability, 1955.) [254]
- Ministry of Agriculture and Fisheries. Bulletin No. 161: British Poisonous Plants. Pp. vi+116+9 plates. (London: H.M. Stationery Office, 1954.) 6s. 6d. [254]
- The Control of Pests and Diseases of Farm and Market Garden Crops. Pp. 16. (Wheatthampstead: The Murphy Chemical Company, Ltd., 1955.) [254]
- North Staffordshire Field Club. Transactions and Annual Report, 1953-54. Vol. 88. Edited by H. V. Thompson. Pp. 127+4 plates +B75-B90. (Stoke-on-Trent: North Staffordshire Field Club, 1954.) 10s. 6d. [254]

Other Countries

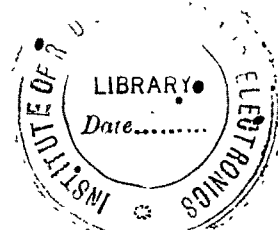
- Institut Royal Météorologique de Belgique. Publications, Série B. No. 13: Observations de la radiation Solaire durant l'éclipsé de soleil du 30 juin 1954. Par R. Dogniaux. Pp. 11. No. 14: Les périodes de grands froids en Belgique (1901-1954). Par Dr. A. Vandenplas. Pp. 30. No. 15: Sur les transformations adiabatiques et isobariques dans l'atmosphère. Par L. Dufour. Pp. 10. Contributions. No. 16: Les aspects météorologiques et climatologiques des Pollutions Atmosphériques. Par L. Poncelet. Pp. 15. No. 17: L'aéronomie et sa nomenclature. Par Dr. M. Nicolet. Pp. 6. No. 18: Étude du climat de la radiation en Belgique. Par R. Dogniaux. Pp. 54. No. 19: Sur l'organisation de la météorologie agricole en Belgique. Par Dr. A. Vandenplas. Pp. 13. (Uccle-Bruxelles: Institut Royal Météorologique de Belgique, 1954 and 1955.) [254]
- Sudan Government: Ministry of Agriculture. Memoirs of Forestry Division. No. 6: Working Plan for the *Acacia nilotica* Forest Reserves, Gezira Circle. By G. A. Booth. Pp. 107. (Khartoum: Agricultural Publications Committee, Ministry of Agriculture, 1954.) 40 P.T. [254]
- United Nations. Demographic Yearbook, 1954. (Sixth issue.) Pp. 729. (New York: United Nations; London: H.M. Stationery Office, 1954.) (Cloth: 7.50/dollars; 55s. Paper: 6 dollars; 45s.) [254]
- New Zealand. Department of Scientific and Industrial Research. Seismological Observatory, Wellington, W.I. Seismological Report for October, November, December, 1951. Pp. ii+22. (Bulletin E. 126.) Seismological Report for January, February, March, 1952. Pp. ii+16. (Bulletin E. 127.) (Wellington: Government Printer, 1955.) [254]
- United States Observatory. Circular No. 56: Positions, Areas, and Counts of Sunspots, November-December, 1954. By Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: U.S. Naval Observatory, 1955.) [254]
- Colloque sur la Protection et la Conservation de la Nature dans le Proche-Orient, Palais de l'Unesco, Beyrouth, 3-8 Juin, 1954. (Organisé par la Société Libanaise des Amis des Arbres et le Centre de Coopération Scientifique de l'Unesco pour le Moyen-Orient.) Pp. 176. (Cairo: Unesco, Middle East Science Cooperation Office, 1955.) [254]
- Progresso Terapeutico: Rassegna Trimestrale di Medicina. Anno Nr. 1 (Genajo-Marzo, 1955.) Pp. 48. (Roma: Il Progresso Terapeutico, Via Ascoli Piceno Nr. 19, 1955.) [254]
- Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Memoir 274: Geology and Mineral Deposits of Alken Lake Map-Area, British Columbia. By E. F. Roots. Pp. ix+246+10 plates. (No. 2514.) (Ottawa: Queen's Printer, 1954.) 1 dollar. [254]
- Board of Grain Commissioners, Winnipeg. Grain Research Laboratory—1954 Report. (Twenty-eighth Annual Report.) Pp. 78. (Ottawa: Queen's Printer, 1955.) [254]
- International Nickel Company of Canada Limited. Address to Shareholders—Annual Meeting, April 27, 1955. By John F. Thompson.

- Pp. 21. (Toronto: International Nickel Company of Canada Limited, 1955.) [254]
- A Doctor's Dilemma: a Lecture given to the Philosophical Society, University College, Ibadan, on November 4, 1953. By Peter Konstam. Pp. 12. (Ibadan: Ibadan University Press.) [254]
- Botany and Medicine in West Africa: a Talk given to the West African Arts Club and the Race Relations Group (Institute of Sociology) at the Friends' International Centre, London, on November 23, 1952. By Dr. F. R. Irvine. Pp. 10. (Ibadan: Ibadan University Press.) [254]
- Proceedings of the New Zealand Ecological Society. No. 1: Report of the Second Annual Meeting, Wellington, 21-22 May, 1953. Pp. 24. 3s. No. 2: Report of the Third Annual Meeting, Auckland, 19th to 21st May, 1954. Pp. 24. (Wellington: New Zealand Ecological Society, 1953 and 1954.) [254]
- Sudan Government: Ministry of Agriculture. Bulletin No. 12: Gezira Soll. By T. N. Jewitt. Pp. i+83. P.T. 25. Memoirs of the Field Division. No. 5: Some Aspects of Agricultural Development in the Sudan. By T. R. G. Moir. Pp. 37. P.T. 15. No. 6: Some Notes on Zandeland. By A. G. McCall and K. L. Lea-Wilson. Pp. i+10. P.T. 74. (Khartoum: Agricultural Publications Committee, Ministry of Agriculture, 1954 and 1955.) [254]
- Canada: Province of Quebec. Department of Mines—Laboratories Branch. P.R. No. 301: A Chemical Study of the Peats of Quebec. 6: The Small Tea Field Bog, Huntingdon County. 7: The Large Tea Field Bog, Huntingdon County. By J. Rist, C.-B. Brunette and H. Girard. Pp. iii+28+3 plates. P.R. No. 305: The Use of the Thermobalance in Analytical Chemistry. By Fernand Claisse, Florian East and Frederic Abesque. Pp. 6+5 figures. (Quebec: Department of Mines, 1954.) [254]
- Carnegie Institution of Washington. Year Book No. 53: July 1, 1953-June 30, 1954, with Administrative Reports through December 10, 1954. Pp. xxxiv+15+311+8 plates. (Washington, D.C.: Carnegie Institution of Washington, 1954.) Paper: 1 dollar; Cloth: 1.50 dollars. [254]
- United States Department of Commerce: National Bureau of Standards. Computer Development (SEAC and DYSEAC) at the National Bureau of Standards, Washington, D.C. (N.B.S. Circular No. 551.) Pp. iv+148. (Washington, D.C.: Government Printing Office, 1955.) 2 dollars. [254]
- Central Board of Geophysics. Publication No. 1: A Compilation of Papers on the Assam Earthquake of August 15, 1950. Compiled by M. B. Ramachandra Rao. Pp. viii+112+29 plates. (Calcutta: Central Board of Geophysics, 1953.) [25]
- Indian Forest Bulletin No. 167 (New Series): On Measurement of Toughness on Timber—Some Preliminary Investigations. By Dr. Franz Kollmann and A. C. Sekhar. Pp. ii+40. (Delhi: Manager of Publications, 1954.) 3 rupees; 14 annas. [25]
- Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 138: (Wood Seasoning)—Indian Timbers for Slate Frames. By M. A. Rehman, Jai Kishore and M. L. Mehra. Pp. i+5. (Delhi: Manager of Publications, 1954.) 6 annas. [25]
- Transactions of the Mining, Geological and Metallurgical Institute of India. Vol. 49, December, 1952: Recommendations of the Implementation Committee and the Proceedings of the Symposium on Training of Personnel for the Mineral Industry, October, 10th and 11th, 1952, Calcutta. Pp. xvii+335. (Calcutta: Mining, Geological and Metallurgical Institute of India, 1954.) 15 rupees. (10 rupees 50 members.) [25]
- Indian Association for the Cultivation of Science. Report of a Symposium on High Polymers (including Rubbers, Resins, Plastics and Fibres), held at the Association on the 29th March and 30th March, 1954, organized by the Physical Chemistry Department, I.A.C.S., with an Appendix containing a list of publications of the Physical Chemistry Dept. Pp. 22. (Jadavpur, Calcutta: Indian Association for the Cultivation of Science, 1954.) [25]

Catalogues

- Eastman Organic Chemicals. (List No. 39.) Pp. 224. (Kirkby, Liverpool: Kodak Limited, 1955.) [25]
- Catalogue No. X160/U: The Minus Seventy Thermostat Bath. Pp. 3. (Croydon: Townson and Mercer, Ltd., 1955.) [25]
- Firmasil Borosilicate Glassware. Pp. 12. (Barnsley: Wood Bros. Glass Co., Ltd., 1955.) [25]
- "Oil Free" Compressors and Vacuum Pumps. Pp. 12. (Parkstone: Northey Rotary Compressors, Ltd., 1955.) [25]
- A. Gallenkamp and Co., Ltd. Publication No. 560: A New Fraction Collector for Column Chromatography. Pp. 2. Publication No. 561: Super-Shaker. Pp. 2. Publication 562: Mettler Analytical Balances. Pp. 2. (London: A. Gallenkamp and Co., Ltd., 1954.) [25]
- Voss Instruments. Pp. 6. (Maldon, Essex: Voss Instruments, Ltd., 1955.) [25]
- Hilger and Watts, Ltd. Publication CH 384: Hilger Metal Ratio Analyser. Pp. 4+1 plate. (London: Hilger and Watts, Ltd., 1954.) [25]
- Sunvic Controls, Ltd. Data Sheet 13: Pulse Height Analyser. Pp. 4. (London: Sunvic Controls, Ltd., 1955.) [25]
- Fielden Electronics, Ltd. Level Control—Tektor Type J. (The Application of Electronic Capacity Relays to Industrial Level Induction.) Pp. iv+28. (Wythenshawe: Fielden Electronics, Ltd., 1955.) [25]
- Eastman Organic Chemicals—Stook Items. Pp. i+60. (Kirkby, Liverpool: Kodak Limited, 1955.) [25]
- Hopkin and Williams Chemical Catalogue. Supplement No. 2: Pp. 4. Supplement No. 3: Pp. 4. Supplement No. 4: Pp. 6. Supplement No. 5: Pp. 8. (Chadwell Heath: Hopkin and Williams, Ltd., 1954 and 1955.) [25]
- Petroleum Films Bureau. A list of 35mm and 16mm Documentary and Instructional Films. Pp. 48. (London: Petroleum Films Bureau, 1955.) [25]
- United States Information Service. The American Library. Recent additions. Pp. 34. (London: U.S. Information Service, 1954.) [25]
- "Pyrex" Laboratory and Scientific Glassware. Pp. 132. (Sunderland: James A. Jobling and Co. Ltd., 1955.) [25]
- Price List of Standard A.C. Industrial Electric Motors, including details of Motors in Stock. Pp. 12 (List A.1). Outputs and Dimensions—Alternating Current Industrial Electric Motors. Pp. 20 (List B.1). (Manchester and London: Lancashire Dynamo and Crypto, Ltd., 1955.) [25]

NATURE



No. 4469

SATURDAY, JUNE 25, 1955

Vol. 175

CONTENTS

	Page
Supply of Science and Mathematics Teachers	1095
Who's Who in American Science	1097
Metaphysics Reconstructed. By F. I. G. Rawlins	1097
Non-ferrous Foundry Metallurgy. By Prof. A. G. Quarrell	1098
Chemical Aspects of Atomic Energy. By Dr. R. Hurst	1098
Protein Structure and Metabolism. By Prof. J. R. Marrack	1099
Heredity, Development and Evolution in <i>Paramecium</i> . By Prof. T. M. Sonneborn	1100
The National Physical Laboratory: Open Day. By A. J. Garratt, M.B.E.	1102
British Non-ferrous Metals Research Association: Open Days	1104
The Water Pollution Research Laboratory, Stevenage	1105
Obituary:	
Prof. E. Regener. By Prof. P. M. S. Blackett, F.R.S.	1107
News and Views	1108
Personal Factors in Accident Proneness. By J. W. Whitfield	1112
Secondary Electron Emission. By S. Rodda	1112
Peptide Chemistry: Chemical Society Symposium. By Prof. H. D. Springall	1115
Cambridge Observatories: Report for 1954	1117
Malayan Annonaceae	1118
Grafting Experiments between the Tomato Varieties, Golden Apple and Oxheart. By A. J. Bateman	1118
A Simple and Rapid Assay of Oxidative Phosphorylation. By Dr. Britton Chance and Dr. G. R. Williams	1120
Letters to the Editors:	
A New Interpretation of the Mechanics of Pulvinar Movement.—Prof. G. F. Asprey and J. H. Palmer	1122
Rhythmic Flight Activity of Certain East African Trichoptera.—Philip S. Corbet and Audfinn Tjønneland	1122
Shell-structure of the Brachiopod <i>Lacazella mediterraneum</i> (Risso).—Prof. Alwyn Williams	1123
Shell-structure of Thecidian Brachiopods.—G. F. Elliott	1124
Feeding of Barnacles.—Dr. A. J. Southward	1124
Chromosome Numbers in the Rutaceae.—Miss S. R. Desai	1125
Properties, Function and Origin of the Alveolar Lining Layer.—R. E. Pattle	1125
A Micromethod for Determination of the Circulating Blood Volume in Chick Embryos.—Dr. Z. Rychter, Dr. M. Kopecky and Dr. L. Lemez	1126
Neurohumoral Control of the Release of Adrenocorticotrophic Hormone.—Dr. L. Martini and C. Morpurgo	1127
Simultaneous Evaluation of Circulating Eosinophils, Polymorphonuclears and Lymphocytes by Phase-contrast Microscopy.—Dr. P. J. Carpentier	1128
Effect of the Rumen on Dietary Fat.—Dr. F. B. Shorland, R. O. Weenink and A. T. Johns	1129
Behaviour of the Ground Substance of Rabbit Dermis in the Course of Skin Treatment with 3-4 Benzpyrene.—Dr. G. Prodi	1130
Tumours induced in Rats with 4'-Fluoro-4-Aminodiphenyl.—J. A. Hendry, Miss J. J. Matthews, A. L. Walpole and M. H. C. Williams	1131
Loss of Biological Efficiency of Cattle-dipping Wash containing Benzene Hexachloride.—James Allan	1131
Biochemical Variations in Inbred Mice.—Dr. D. Hamer	1132
Potentiating Action of Chlorpromazine and Reserpine.—Bernard B. Brodie, Parkhurst A. Shore, Stanley L. Silver and Robert Pulver	1133
Phosphorylase Activity in Relation to the Layering of Starch Granules.—Prof. N. P. Badenhuizen and M. I. Malkin	1134
Effect of Particle-Size on the Quantitative Determination of Quartz by X-ray Diffraction.—R. L. Gordon and Dr. G. W. Harris	1135
Unusual Waveguide Characteristics associated with the Apparent Negative Permeability obtainable in Ferrites.—G. H. B. Thompson	1135
A Double-walled Vessel for the Distillation of Highly Inflammable Liquids.—C. C. Smith	1136
Recent Scientific and Technical Books	Supp. viii

Editorial and Publishing Offices of Nature

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2

Telephone Number: Whitehall 8831. Telegrams: Phusis Lescuare London

Annual Subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to

T. G. Scott & Son, Ltd., Crown House, 143-147 Regent Street, London, W.1

Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

DIFCO

BACTO-CEPHALIN CHOLESTEROL ANTIGEN

For Hanger Flocculation Test

An approved and stable reagent for use in the Hanger Flocculation Tests to determine disturbance of liver function. Available in packages of six units, each unit equivalent to 150 ml. final test antigen.

Hanger: J. Clin. Invest. 18:261:1939.

BACTO-THROMBOPLASTIN

For Prothrombin Determination

A stabilized rabbit brain substance for use in determining the Prothrombin Time of Blood. Bacto-Thromboplastin is applicable to the procedures described by Quick, Link-Shapiro, Smith, et al., Kato and Poncher, and other tests requiring a potent thromboplastin. Each box of Bacto-Thromboplastin contains 6 ampoules, sufficient for 210 Quick determinations or 420 Link-Shapiro determinations.

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

Sole Agents for Great Britain

BAIRD AND TATLOCK (LONDON) LTD.

FRESHWATER ROAD, CHADWELL HEATH, ESSEX

We Export for Dollars

Wm. DAWSON & SONS, Ltd.

*World's Largest Stockists
of Scientific Periodicals*

COMPLETE LIBRARIES PURCHASED

BUYING?

Suppliers to all Leading
Universities, Public Libraries
and Institutions of the World.
Catalogues issued.

SELLING?

Specialists in Scientific,
Technical Books and
Publications of all
Learned Societies.

Why not consult us first?

4 DUKE STREET, MANCHESTER SQUARE,
LONDON, W.1

Insulated Inspection Mirror



A one-piece steel handle securely soldered to a shell carries a 24 mm. diameter glass dental type mirror. All the exterior is coated with a thick continuous layer of synthetic insulating compound.

The mirror can be used with convenience and safety for the inspection of switch gear, relays, etc.

No. 1195 either plane or magnifying mirror.

List No. 168 illustrated and describes this and other dental types of inspection mirrors.

MANUFACTURED BY

GOWLLANDS LIMITED

MORLAND ROAD, CROYDON, SURREY

Obtainable from Small Tool or Scientific Instrument Dealers

SUPPLY OF SCIENCE AND MATHEMATICS TEACHERS

SOME of the general implications of the report of the Appleton Committee on the Supply of Teachers of Mathematics and Science in Scotland have already been discussed in these columns (*Nature*, June 18, p. 1051). Apart from these general recommendations, the report includes a number of detailed comments and suggestions for dealing with the specific problem it was set up to consider.

Among these recommendations is one dealing with salaries. The report does not underestimate the importance of the question of salaries as affecting the number of specialist teachers of mathematics and science. It thinks that excessive competition with industry would be inexpedient and even harmful; though it considers that specialist teachers have some cause for discontent when they see others, with equivalent qualifications, earning much higher salaries. It is the lower maxima that are the real problem: at the start the specialist teacher is paid as well as, or better than, his colleague in industry or the Scientific Civil Service.

For these reasons, and to ensure that teaching continues to attract some of the best honours graduates, the Appleton Committee recommends increasing the basic maximum for men specialists from the present figure of £960 to £1,150 per annum, with corresponding changes in the women's scales. It does not recommend reduction of the present period covering the increase from minimum to maximum, but comments on the length of this period and the small increments. It also recommends an increase in the special allowance to sub-specialist teachers of mathematics and science to £95 in place of the present £25 per annum. It considers that rather too much stress is laid at all stages of the teacher's career on initial qualifications. It is thus difficult for a man, however distinguished his teaching service, to surmount any shortcomings in his original qualifications; and there are also areas in Scotland where promotion is based excessively on seniority. Also, the highest promotions in the profession take the teacher away from active teaching. It is undesirable, in present circumstances, that a highly qualified person should give up advanced class-work mathematics or science for a minor post of responsibility in a junior secondary school; and the Committee recommends, therefore, the institution of a new post, that of senior assistant, for teachers, not principal teachers but those who are doing advanced work in senior schools, and that these teachers should receive additional salary to compensate them for loss of the responsibility payments that they might have expected to receive had they transferred to junior secondary schools. The Committee found no substance in the representation that, because of the tradition and prestige of classics, teachers of mathematics and science receive less than their due share of available promotions. The lack of laboratory assistants, it considers, has also been over-stressed as a deterrent to recruitment, though in larger schools

employment of a laboratory assistant may be desirable, and in the critical period immediately ahead of us more use must be made of less highly qualified persons.

It is likewise essential that there should be no waste of highly skilled man-power outside the teaching profession, and the report thus endorses the action already taken by the Government to ensure the most economic use of scientific man-power in all branches of the national life. Two specific recommendations are made by the Committee for the use and up-grading of third-class honours graduates in mathematics and science in teaching. It also recommends amendment of the regulations for the training of teachers so that teachers are specially trained to teach modified classes in junior secondary schools in place of the sub-specialist teachers at present used, and also so that the sub-specialist qualification becomes a principal qualification for secondary work.

These long-term remedies should stimulate recruitment, so that the supply of mathematics and science teachers should become more adequate from the middle 'sixties. To alleviate the grave shortage during the next ten years, the Appleton Committee recommends measures to ensure the fullest use of personnel in the schools. Dilution must be carried much further along the lines already indicated, and the fullest possible use made of retired teachers. It is improbable that the number of retired specialist and sub-specialist teachers of mathematics and science under the age of seventy who could be obtained would at any time exceed 200; but even so, their help would be invaluable. The Committee thus recommends that while the period of shortage continues, mathematics or science teachers continuing in or returning to service between the ages of sixty-five and seventy should receive the full salary for their post together with full pension. If this proposal is unacceptable, the Committee makes two minor proposals to remove the discouragement to continued service which present pension regulations offer. It also comments on the absence of benefits for widows and dependants of deceased teachers, and the desirability of utilizing part-time services where available. After weighing carefully the divergent views on teacher training, it recommends no reduction in the length of training courses for specialist teachers of mathematics and science, but that allowances, independent of parental income, should be given during this training year which would cover fees and some £250 of maintenance expenditure. Further, on National Service the Committee reached an early conclusion that graduates with first- or second-class honours in mathematics and/or science who had undergone a course of teacher training should be deferred from national service while the present acute shortage of such persons continues, and as long as they are prepared to teach their subject in the schools.

This proposal goes appreciably further than that recommended by the Federation of British Indus-

tries and is fairer both to the schools and to the Armed Forces. A letter to this effect was sent by Sir Edward Appleton to the Secretary of State for Scotland in May 1954. The step was taken with some reluctance, and the Committee made it not in the interests of education *per se* but in the wider national interests; the position is completely without parallel among teachers of other subjects, but indefinite deferment should not be continued longer than the situation demands.

As already noted, the Appleton Committee firmly rejects the idea of less science teaching in the schools. It does not believe that school laboratories in general are as unsatisfactory as to defer the recruitment of science teachers, or that there are real obstacles to the use of women part-time teachers. It is doubtful, however, whether any appreciable part-time assistance is available from industry or the universities, even if the difficult salary questions could be overcome, nor does it favour the idea of compressing university courses.

Of the repercussions of these proposals the economic effects are probably the least important. To give the recommended increase in salaries to all specialist teachers of mathematics and science would cost about £120,000 in Scotland; to give it to all specialist teachers in Britain would cost some £600,000, and the proposals for sub-specialists would cost another £400,000 if applied to all sub-specialists. On the basis of the figures for the shortage given by the Federation of British Industries' Committee, the proposals of the Appleton Committee might cost some three or four million pounds if applied to the whole of Britain.

This is not an expenditure lightly to be incurred; but on the evidence presented in the Appleton report, it is a small sum to pay to remove a serious danger to the national interest. The difficulty lies rather in determining how best it can be provided without undesirable repercussions, such as weakening local government. It may well be that, as Dr. B. V. Bowden, principal of the Manchester College of Technology, pointed out in a forthright presidential address to the North-Western Branch of the Science Masters' Association last November, the payment of schoolmasters' salaries from the rates is an archaic means of taxation. Local interest in and responsibility for education are not archaic; they are an essential condition of a live democracy, and the real financial problem is to remove anomalies and disparities and to raise standards without impairing local interest and responsibility.

Dr. Bowden's address has received nothing like the attention it deserves. Many of his points are indeed also made by the Appleton Committee; but his address provides illustrations which emphasize those points, and his comments are sometimes more trenchant than could be expected from a Government-constituted committee. He puts, for example, the cost of the Federation of British Industries' Committee's proposal in its right perspective against expenditure on university education in general; he does not hesitate to point out that if the additional money is to be found, it will be at the expense of

other social services like housing, and he condemns the preposterous egalitarianism which has been forced on the teaching profession by its non-graduate members. Nor does he fail to remind science masters that a part of the remedy lies in their own hands: the most generous salary scales will not attract recruits of high quality unless science masters themselves have a high ideal of their calling, and can convey some of their respect for their calling to some of their pupils.

These are not points that either political party has been honest or courageous enough to face or to tell the public; but they need making. Disregard of them will frustrate any attempt to deal with a shortage which threatens to endanger the whole educational system of Britain and with it our industrial and economic life. Dr. Bowden argues, indeed, that science teaching at present depends to an alarming extent upon the loyalty of members of the staff who were appointed before the War. These men are not being replaced, and when they are gone the whole of our educational system may collapse completely. Without science masters there will be no science teaching, and without science teaching the universities and technical colleges will not receive competent students; and ultimately industry will be deprived of its supply of trained engineers, scientists and technologists and be brought to a grinding halt.

Dr. Bowden points out more clearly than some other participants in this discussion that this extreme shortage of science teachers has persisted since 1939, and that its continuance for another fifteen years could bring science teaching in Britain to an end. Moreover, this numerical conspectus takes no account of the fact that the teaching of science in our sixth forms before the War was the best in the world, as well as the basis of all our university work, or of the influence of the science master in turning the thoughts of his pupils towards a career in science or technology. In default of that influence, moreover, whatever steps may be taken to facilitate transfer from the arts to the science either at the sixth-form stage or in the university are likely to fail of their full effect.

What stands out from Dr. Bowden's address and from the report of the Appleton Committee is not so much the urgency of the problem as the need for imagination and courage in dealing with it. Administrative convenience could well wreck our whole economy if it is allowed to hinder official recognition that good science teachers are more valuable to that economy than any of their colleagues. The pursuit of false egalitarianism in the teaching profession or in politics could be equally fatal, for besides adjustment of the salary scales as recommended in these reports, the question of quality is all-important. It is the vision and character of the science teacher that will be the decisive factors in encouraging more students to take up a career in science and technology, just as his competence as a teacher plays a large part in developing their latent ability to its full extent. It is from the science master in the first instance that the student is likely to glimpse the fascination of science and technology as living and growing subjects, and the varied opportunities of a

satisfying career which they offer. If science teaching is to find an honourable place among those opportunities and attract young students to such a career, it will largely be in such measure as the student glimpses in his science master the sense of satisfaction in a high vocation, in the service of worthy ideals which are at least as important to a full life as monetary rewards. To deal effectively with the shortage of science teachers demands both long-term and short-term measures. It may well involve fresh thinking about general education and the standards of university entrance—even about the purpose of university education and of secondary education. First and foremost, however, it demands giving honour where honour is due, that is, according to the science teacher the place in the public esteem that the nature and importance of his work demand and treating him accordingly. Of the teacher it demands that he shows himself worthy of that esteem and allows no false ideas of egalitarianism to lead him to forsake the traditions and standards that, as Dr. Bowden reminds us, made the educational standards in our sixth-forms the best in the world.

WHO'S WHO IN AMERICAN SCIENCE

American Men of Science

A Biographical Directory. Edited by Jaques Cattell. Ninth edition. Vol. 1: Physical Sciences. Pp. v+2180. (Lancaster, Pa.: Science Press; New York: R. R. Bowker Company, 1955.) 20 dollars.

ONE of the phenomena of the twentieth century has been the enormous expansion in scientific and technological effort throughout the world, and in no country has this been more marked than in the United States. An indication of this expansion can be gauged from the fact that in 1900 the first edition of "American Men of Science" contained four thousand names, the eighth (1944) some fifty thousand, and the ninth, of which this is the first of three volumes, will have an estimated ninety thousand entries. Of course, it can be argued that the sizes of the various editions may not be proportional to the country's scientific effort, since a compiler can be more (or less) selective in preparing a new edition. Nevertheless, a noteworthy feature of "American Men of Science" is that, since its inception, it has been in the hands of but two editors, and these are father and son: J. M. Cattell was the original editor, and the present work is the responsibility of Jaques Cattell. Thus throughout the lifetime of this work the editorial policy is not likely to have suffered any abrupt changes, and it can be fairly deduced that the growth of "American Men of Science" does, in fact, measure the growth of North American science (Canadian workers are included).

A glance at the editor's preface of the present volume reveals some of the difficulties that had to be faced in compiling the new edition. In the planning stage it was estimated that eighty thousand names would need to be entered, and so it was decided to break the work up into three volumes, on the physical sciences (the present volume), biological sciences and social sciences, respectively. In fact, this was an underestimate, for the original calculation of thirty-

five thousand names for Vol. 1 has turned out in practice to be 43,518, and the total is expected to run to more than ninety thousand. Now that the work is split into three parts, a new problem arises as to which volume a borderline scientist belongs; in particular, this problem arises between Vols. 1 and 2, when dealing with biochemists and biophysicists. In each such case the individual concerned was given the choice of which volume he preferred to appear in, and for most of them a "see reference" has been inserted in the other volume. One cannot help feeling that this has led to a great deal of extra work and complication, all of which could have been obviated if the three volumes had simply covered all the names in alphabetical order. From the user's point of view, if one knows nothing about a scientist except his name, he may be in any of the three volumes. The principal advantage seems to be that those who are interested in but one branch of science need only buy one of the volumes; but for a work of reference such as this, it is far more likely that purchasers will want all three.

Of the other changes for this ninth edition, one that immediately strikes the eye is that an offset printing process has been used throughout, and consequently the lines are not of uniform length. This gives a rather untidy appearance; but it does not diminish the value of the content, and there may well have been over-riding technical and/or economic reasons for choosing this method of printing. A less obvious change is that the former practice of allotting asterisks to a select few who are judged to be outstanding in a particular science has been abandoned. This is a change for the good; there must always be some difficulty (and misjudgment, too) when deciding whether or not to include a particular name in the work, but to attempt to classify those already in as 'ordinary' and 'extraordinary' seems to be making an unnecessary and invidious distinction which an editor would be well advised to eschew. A feature of the work that is to be commended is that Christian names are given in full and all but the first letter are bracketed off in those cases where the bearer wishes to be known by an initial. This is particularly suited to American conditions, since in the New World many people prefer to use their Christian names (and often not the first one) in conjunction with their surnames.

In general, this is a work of reference that has a definite place as the "Who's Who" of North American science. As with all such books, it may contain a few names that scarcely deserve the honour, and almost certainly there must be more than a few scientific workers who are not listed but who could with justice be given an entry. Nevertheless, the work has stood the test of time, and this volume is worthy of the tradition established by the previous editions.

METAPHYSICS RECONSTRUCTED

The Metaphysics of Logical Positivism

By Gustav Bergmann. Pp. x+341. (London: Longmans, Green and Co., Ltd., 1954.) 42s. net.

THIS book consists of a selection of essays which the author has contributed to various philosophical journals over the course of several years. They have not been re-cast, and perhaps on that account are the more valuable as showing the development of an active mind as it battles with the

changes in a somewhat fickle intellectual climate. As the title would indicate, much of what is said rests upon the basic researches in Britain of Moore, Russell and Wittgenstein. We are presented with a well-balanced account of what logical positivism is—and always has been—coupled with a just assessment of the differences of emphasis between the disciples of the Vienna Circle and the rest of the world.

The drift of the writer's thought, as he takes a very wide sweep around his subject, tends (perhaps unavoidably) to obscure the relations, often rather strained, between logical positivism and metaphysics which, after all, are what he is engaged in discussing. Logical analysis is assuredly held to be a reasonable concept of philosophy, and its study involves a close scrutiny of language as we normally use it as a rough-and-ready means of receiving and imparting information. In a limited sense, and apparently only with respect to traditional forms, metaphysics is rejected. This, if I understand the thesis aright, is a rather more liberal position than usual. In the chapter on reconstruction, we find the remark that an "unexamined metaphysics" is the worst of all. This seems to suggest that there may be systems in themselves capable at least of investigation which would not come under the lash. This is very near the plea advanced a few years ago in quite another context that metaphysics must be adaptable and sympathetic to development if it is to be taken seriously as a true *scientia*. Most people would readily agree.

Meanwhile, mankind has become aware—and during recent years maybe increasingly aware—that there are 'events' (as Whitehead might have said) which can be both apprehended and measured, and those which can be apprehended but not measured. This distinction, made explicit many years ago, is perhaps the operative link between the exact sciences and those like aesthetics and sociology which receive attention towards the end of this volume. There can be little doubt that metaphysics, as a distinct subject of study, is called upon to do much more than "to save appearances" if it is to save itself and the great service which it has been able to render to scholarship through the ages.

Philosophy's task is above all to recognize problems as problems, and to evolve a language suitable for their precise formulation. F. I. G. RAWLINS

NON-FERROUS FOUNDRY METALLURGY

Non-Ferrous Foundry Metallurgy

The Science of Melting and Casting Non-Ferrous Metals and Alloys. Edited by Prof. A. J. Murphy. Pp. x+498. (London: Pergamon Press, Ltd., 1954.) 70s. net.

AS with many other branches of production metallurgy, foundry work developed during the centuries as a craft and then only quite recently as a technology based on an understanding of the underlying scientific principles. Indeed, the scientific study of foundry problems has been made mainly during the past twenty or thirty years, and foundries still exist which depend for their existence upon the experience and skill of their foundrymen, rather than upon the application of scientific knowledge. The industry as a whole, however, is now alive to the value of the scientific approach to technical problems

and will welcome this book, to which a number of well-known foundry metallurgists have contributed.

The book is logically arranged. Approximately the first third is devoted to a scientific treatment of liquid metals, gases in metals and solidification. These chapters are well written and form a sound basis on which the rest of the book is built and on which the reader may reasonably expect to attempt a solution of his own foundry problems.

By contrast, in the long chapter on non-ferrous foundry technology the emphasis is upon practical details rather than on principles. The authors seem to regard their treatment as sufficient in itself; but some readers are likely to feel the need for amplification of certain points and will regret that references to other sources have not been included. It can scarcely be claimed that the section on ingot casting is comprehensive, and yet there is not a single reference to another work on the subject. Nor, in a chapter avowedly on technology, would one expect to find the shell-moulding process dismissed in a short paragraph; there is considerable interest in this essentially post-war development, and a much fuller account would have been justified.

The factors that influence the properties of castings are discussed in some detail in the next section, which also includes an authoritative account of the various methods of measuring the gas content of cast metals and a review of non-destructive testing. Most of the latter is concerned with radiographic examination, and there is only brief reference to ultrasonic and other methods.

In the final and longest section, seven well-known metallurgists discuss the foundry characteristics of the principal casting alloys classified according to their respective basis metals. The information provided is based on practical experience as well as on an appreciation of the scientific aspects. It should prove particularly useful to those who have occasion to make castings in alloys hitherto outside their experience.

Taken as a whole, the book is a useful addition to the literature on foundry metallurgy and deals with all aspects of non-ferrous practice. The foundry industry will benefit if the book is widely read by its metallurgists. There will certainly be other editions, and it may not be out of place to suggest that in future the names of the contributors should appear on the table of contents so that readers can more easily find out who has written what they are reading.

A. G. QUARRELL

CHEMICAL ASPECTS OF ATOMIC ENERGY

The Actinide Elements

Edited by Glenn T. Seaborg and Joseph J. Katz. (National Nuclear Energy Series: Manhattan Project Technical Section. Division 4—Plutonium Project Record: Vol. 14A.) Pp. xxx+870. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 94s.

THIS volume of the National Nuclear Energy Series is a companion to the earlier "Trans-uranium Elements"; but whereas that was a collection of research papers, the present book is a series of reviews by experts and maintains a high standard of writing throughout, giving a much more balanced and useful account of the chemistry of the

heavy elements so far as the general reader is concerned.

With the development of a large-scale nuclear power programme, a considerable chemical industry will also arise to fabricate and reprocess the fuel elements, and some knowledge of the chemistry of the heavy elements is necessary to an understanding of the basis of this industry which must gradually involve more and more chemists and chemical engineers from outside the official projects. To the student and teacher of chemistry, there is also much of interest, since many advances in inorganic chemistry have been made in this field. Moreover, research which has for a decade been largely conducted in the secrecy of government laboratories is once more being pursued in universities, now that the basic chemistry is being freely published in journals and books.

The chapters may be divided into categories. First there are those appealing mainly to a radiochemist, such as five dealing with the nuclear properties of all the isotopes of the elements from thorium to californium; and two on radiochemical techniques which give very full and authoritative accounts of separation methods and of alpha and fission counting respectively. There is then a group of chapters reviewing the basic chemistry, element by element, from actinium to the transplutonium elements taken together. Each chapter is sufficiently complete to be used as a general source without becoming a mere catalogue. The chemistry of plutonium, as befits an element of strategic and economic importance, is covered in three chapters. That on oxidation-reduction reactions and equilibria in solution contributes a great deal to clarify a very complex situation arising from the possibility of four valency-states co-existing in solution. Equally important is the chapter on ionic and molecular species in solution, where complex-ion formation has striking effects. Finally, there is an exhaustive dictionary of plutonium compounds, giving preparation and properties.

There are two rather specialized chapters reviewing the crystal structure and optical properties of compounds of the actinides, and one of the final chapters discusses the correlation of the chemical, spectroscopic, magnetic and crystallographic evidence, with respect to electronic structure and place in the periodic table; a very strong case for an actinide transition series is made out, although this is to-day a controversial point only for gaseous atoms.

The book is very well produced and remarkably free from misprints and errors, but rather expensive for the general reader.

R. HURST

PROTEIN STRUCTURE AND METABOLISM

Serological Approaches to Studies of Protein Structure and Metabolism

Edited by William H. Cole. (Rutgers University: Bureau of Biological Research Annual Conferences on Protein Metabolism.) Pp. xi+97. (New Brunswick: Rutgers University Press, 1954.) 2 dollars.

POSSIBLY someone who is interested in protein structure and metabolism and is not soaked in serology would be better equipped than I to review this book. He might be better able to judge how far the book indicates the possible applications of serology and warns of the difficulties and limitations.

Heidelberger gives an outline of the quantitative methods that have been used in much of his work and have, together with Landsteiner's work with artificial antigens, formed the basis of most of our theories about antibodies and their reactions. Gitlin and Boyden describe techniques that may be very useful in quantitative work. I have only one small criticism of Munoz's excellent review of the gel diffusion method: he does not mention the great value of Ouchterlony's method of distinguishing cross-reactions between two preparations, due to two similar but not identical antigens (such as hen and duck ovalbumin), from cross-reactions, due to the presence of a common antigen.

Cohn describes an exciting application of serology. In the presence of a number of β -galactosides, *Bacillus coli* forms β -galactosidase (Gz), which is a good antigen. In the absence of a β -galactoside, another protein (Pz) which is not antigenic is formed. Pz forms a precipitate with antiserum against β -galactosidase, but when the two compete the latter is precipitated preferentially; both can be measured in mixtures of the two. All species of Enterobacteriaceae that form the same β -galactosidase, or are capable of a mutant that does, contain Pz; those that are never known to form β -galactosidase do not. The formation of β -galactosidase in the presence of a β -galactoside leads to a decrease in the rate of formation of Pz; but the latter is not a precursor of β -galactosidase. There is no evidence of a dynamic equilibrium between β -galactosidase and other proteins.

Gitlin describes quantitative experiments that show that the serum albumin, in cases of nephrosis, and urinary albumin are serologically identical with normal serum albumin, and that in a gammaglobulinemia and a fibrinogenemia the rates of synthesis of γ -globulin and fibrinogen are reduced. Boyden describes the application of a quantitative method to the correlation of the serological and the taxonomic relationships of animals.

Haurowitz finds that the labels of certain labelled proteins survive, apparently attached to protein, in cytoplasmic granules of reticuloendothelial cells of liver and spleen, and concludes that antibodies are made in these granules.

Now, I must turn to the difficulties and traps. There is no suggestion in the book that it may be difficult to get satisfactory antisera against some antigens—haemoglobins, for example. There are indications in the articles on gel diffusion and on serological correspondence that considerable amounts of antibody may be formed against impurities of the antigen used for immunization. These antibodies have led to errors in attempts to identify and measure proteins by serological methods, and they probably account for the earlier claims that serum albumin in nephrosis differs from the normal serum albumin. I think the possibility of their presence in antisera is an objection to Boyden's method in which equal weights are given to antibody and antigen excess zones; the results may be unduly weighted by minor constituents. The conclusions may not be seriously affected when whole sera, which may contain the same constituents in roughly the same proportions, are compared; but when single proteins (such as hen and duck ovalbumin) which may contain variable amounts of impurity (for example, conalbumin) are compared, the results may be seriously affected; it becomes essential to avoid the antigen excess zone.

• J. R. MARRACK

HEREDITY, DEVELOPMENT AND EVOLUTION IN *PARAMECIUM**

By PROF. T. M. SONNEBORN

Indiana University, Bloomington

THE ciliated Protozoa include within a single protoplasmic mass or cell both the germ plasm (micronucleus) and soma (macronucleus and cytoplasm). The uniqueness of this and other features of their organization (see below) lends special comparative interest to their general biology. Using current knowledge of the most fully investigated ciliate, *Paramecium*, an attempt to give a synoptic view of this thesis will now be made. For details of the biology and genetics of *Paramecium*, the reader is referred to Kalmus¹, Sonneborn², Wichterman³ and Beale⁴.

Heredity

The prevailing genetic system in *Paramecium* is the classical Mendelian system. In *P. aurelia*, more than twenty single gene traits have been demonstrated, including several examples of multiple alleles; but no case of linkage is yet known. These conventional genetic results are solidly founded on an essentially conventional pattern of nuclear and chromosome behaviour at meiosis and fertilization. Though *Paramecium* is normally diploid, haploids are readily obtained, polyploids have been reported, and crosses of haploids by diploids yield abnormalities which are probably aneuploids. As in other organisms, the commonly used mutagenic agents are effective in inducing mutations. The chromosome theory has thus been extended to almost the farthest, and surely the most unique, reaches of the animal kingdom. *Paramecium* has proved itself entitled to a place in good standing in the world of genetics.

Another kind of heredity, clearly of subordinate rank in *Paramecium*, has been widely debated. All examples of it involve a single kind of particle, called kappa, found in the cytoplasm of some strains. Kappa determines a limited class of traits: production of, and resistance to, certain poisons, and associated physiological peculiarities. Although at first hailed as the best, almost the only, example of cytoplasmic inheritance in animals, kappa is now looked upon by most geneticists as a foreign organism. The change of interpretation was due mainly to three discoveries: though in the cytoplasm, kappa contains deoxyribonucleic acid; it is not precisely distributed to daughter cells, may be lost, and is not essential for life; and it is transmissible by infection as well as by heredity. However, it has been pointed out⁵ that each of these features of kappa is occasionally exemplified by well-recognized genetic materials; and careful studies⁶ of kappa not only fail to identify it with any known type of organism, but also reveal marked differences from all those types (algae, viruses, bacteria and Rickettsiae) with which various authors had speculatively claimed to identify it. The facts prove neither that kappa is, nor that it is not, a parasite. In Lederberg's⁷ useful terminology, it is a plasmid. Its chief present interest is as a model case on the important borderland between genetics and parasitology. In this connexion, the following are some of the main discoveries:

(1) When a semi-independent reproducing unit is contained within a cell, as in the case of kappa within

a cell of *Paramecium*, and the two multiply at different rates, the problem arises as to how the inner one varies in quantity as the containing cell reproduces. The quantitative formulation of the solution by Preer⁸ for the kappa case is generally applicable to cases of this sort. (2) When two types of plasmids coexist in the same cell, how—if at all—do they affect each other? Dippell⁹ and Hanson¹⁰ have examined this problem in the case of pairs of types of kappa. They find that the results depend upon the particular types of kappa and on the conditions. Two types may be maintained in equilibrium or the equilibrium may shift in either direction, in the extreme case one type being lost entirely. Certain combinations of types exhibit symbiotic relations, one permitting the other to reach intracellular population-levels it could not attain alone. Such studies could lead to control of populations of plasmids, with obvious implications for therapy of intracellular parasites. (3) Reciprocal interactions occur between kappa and the nuclei of *Paramecium*. The amount of kappa in the cell is proportional to the dosage of one gene (*K*), permitting the exploitation of kappa as a measure of gene action¹¹. Another genotype (*kk*) normally results in rapid loss of kappa; but when exposed to certain conditions at a critical time, it maintains kappa¹². The possibility that, in this case, kappa may be acting as an agent of intracellular transduction of genes from one nucleus (*K*) to another (*k*) is under investigation. Finally, a special kind of killer contains a kappa (called *mu*) that determines injury to, and even destruction of, micronuclei¹³. The nature of this genetic damage remains as yet unknown.

Development

Differentiation in *Paramecium* is largely intracellular, most of it being completed before the first post-zygotic fission. Differentiation, development, growth and maintenance of all functions are dominated by the action of the macronucleus. The micronucleus may be lost without vegetative damage; but loss of the macronucleus is quickly followed by degeneration and death¹⁴. Immediately meiosis and union in conjugation become impossible. Feeding and growth soon cease; no divisions occur; death comes within about two days. When both types of nuclei are present and contain different genes, no effects of those in the micronucleus can be detected¹⁵.

Two of the important early differentiations are nuclear. The first is a differentiation of the first four products of the fertilization nucleus into two micronuclei (diploid) and two macronuclei (highly polyploid). This differentiation is correlated with brief localization of the nuclei at opposite ends of the body: the two at the posterior end become macronuclei (Chao, unpublished). Immediately the two types of nuclei migrate to the same body region and thereafter lie side-by-side and reproduce true to type at all subsequent fissions. This differentiation into germinal and somatic nuclei is irreversible. At about the same time, the macronucleus becomes irreversibly determined as to the mating type it will control. The nature of this second nuclear differentiation is unknown. Both nuclear differentiations can be effected by the

* Substance of three lectures delivered at University College, London, during March 9-11.

cytoplasm, which is itself under control of the pre-fertilization macronucleus¹⁴.

Two later differentiations also involve the macronuclei. The first is reversible and can occur at any time. This is the type of antigen carried on the many cilia⁴. Any one of several may be present: but as a rule all cilia of one cell and of its descendant cells carry the same antigen. Changes of serotype can be induced by a number of conditions, the new type of antigen persisting long or permanently during reproduction under standard conditions. The array of potential serotypes is determined by a corresponding array of non-allelic genes in the macronucleus. The environment and cytoplasm determine which of these genes comes to persistent expression.

The second later differentiation is progressive and continuous. It is characterized by decreasing fission-rate and increasing frequency of abnormality and death until all progeny are dead after at most somewhat more than three hundred successive fissions. These age changes seem to be due to progressive chromosomal unbalance resulting from the amitotic division of the macronucleus, as suggested by Fauré-Fremiet¹⁷. The germ plasma (micronucleus), lying directly in the increasingly abnormal cytoplasm, shows also progressive deterioration: the chromosomes become chromatin-poor, clump on the spindle, and are unequally distributed at mitosis and meiosis. This leads to increasing frequencies of abnormal and non-viable offspring at autogamy, as the parent clone ages, and ends with 100 per cent death at autogamy in parents about two hundred fissions old or older. Micronuclear damage is not accumulated at a uniform rate, but is specifically a feature of senescence. By means of conjugation, a normal micronucleus from a young cell may be substituted for the genetically damaged nucleus of an old cell. This results in complete rejuvenescence. The disastrous individual and genetic consequences of senescence are largely, if not exclusively, a laboratory phenomenon due to continuous overfeeding under uniform conditions. Either autogamy or conjugation is probably induced early in Nature, for starvation is their natural stimulus.

The gullet regularly disappears when the defective micronuclei in old cells come into action, through their derived macronuclei, after autogamy in very old clones. Substitution of a normal nucleus (see above) prevents this (Dippell, unpublished). Hence, the maintenance of the gullet depends on the macronucleus. This is of special interest because the gullet is a visibly self-multiplying structure at fission. As with kappas, a proper nuclear constitution is needed for maintenance of a self-reproducing cytoplasmic structure. Conversely (see above) nuclei are injured and lost in defective cytoplasm.

Evolution

Though world-wide in distribution, populations of *Paramecia* are isolated in a pond, lake or stream and their means of migration are not clearly known. Theoretically, single populations of any size could be homozygous and uniform; but diverse types are known to occur together¹⁸. Also the same genotype, even a rare one, may be found year after year in the same place. Taxonomists recognize eight to sixteen species, differing in morphology³. Each of these that has been studied extensively consists of a number (8-18) of genetic species³.

The genetic species of one taxonomic species exhibit geographical, sexual and genetic isolating

mechanisms. For example, some species of *P. aurelia* are rather narrowly localized, while others are widely distributed¹⁹ and most combinations of species cannot mate with each other; only a few interspecific crosses can be made. In one combination of species, the basis of the genetic bar to gene flow lies in a mutual incompatibility between the nucleus of each species and the cytoplasm of the other, yielding non-viable F_1 ¹². Similar non-viability of the F_1 , appearing earlier, during the cross, is known for one combination of species of *P. bursaria*²⁰. In most species crosses in *P. aurelia* the F_1 survives, but the F_2 and back-cross generations fail to yield viable recombinants²¹.

Similar, but less extensive, non-viability of recombinants appears after crosses of any two strains from different natural populations²². From 15 per cent to more than 90 per cent of the autogamous F_2 may die in crosses of different strains. This probably has its basis in the distinctive chromosome sets of each natural strain. The strains of the one species of *P. aurelia* thus far examined form an aneuploid series (with $n = c. 35-50$) and the chromosome sets differ also in size and shape²³. The preservation of suitable new genotypes is facilitated by the occurrence of autogamy and mechanisms for permitting conjugation between animals of identical genotypes. There is thus in Nature a continuous gradation from complete viability following clonal crosses within a strain up to 100 per cent non-viability in the F_2 of certain species crosses and finally to complete sexual isolation.

The breeding systems have evolved to serve two functions: the prevention or cure of senescence by periodically producing new balanced macronuclei, and the production of genetic recombinations. The mechanisms for bringing about outbreeding are most efficient in *P. bursaria*. Inbreeding leads to high mortality²⁴, autogamy does not occur, selfing is rare, diverse mating types rarely arise from the progeny of a single pair of conjugants, and the existence of systems of multiple mating types favours the occurrence of conjugation. On the contrary, other species with low mortality after inbreeding may have autogamy, frequent selfing, frequent occurrence of diverse mating types among the progeny of a single conjugant pair, and systems of only two mating types. The latter arrangements favour the frequent occurrence of fertilization under conditions in which recombination is excluded, thus indicating the existence of another function. In agreement, ageing is more rapid in such species²⁴ than in *P. bursaria*²⁵.

The genetic system in *Paramecium* shows striking integration of nucleus and cytoplasm into a highly evolved complex^{16,26}. The mechanism of determining macronuclei, the mechanism of mating-type determination and ageing with its genetic consequences (see above), all involve systems in which the nuclei are determined by the cytoplasm and the cytoplasm by the nucleus to yield cyclic nucleo-cytoplasmic inter-determinations. Ever if the genes were the exclusive original genetic materials which created the cytoplasm, there are here three important examples of how the created has become able, Pygmalion-like, reciprocally to control its creator.

The evolution of the morphological features of *Paramecium* illustrates what may be one of the most fundamental features of evolution. The Ciliates are believed to have evolved from the Flagellates. From the simplest to the most evolved Flagellates, the most outstanding feature of morphological evolution

has been increase in the number of fibre-forming granules and in the kinds and complexities of the fibrous structures they produce²⁷. The most primitive forms have a single granule and a single fibrous structure, the flagellum. The most evolved forms have large numbers of granules forming not only flagella but also axostyles, costa, cresta, parabasal bodies, etc., of varying complexity. Replication of the basic structure, the unit granule, was followed by differentiation among its products. In the Ciliates, these granules (kinetosomes) and their fibrous products lie in rows below the body surface²⁸. *Paramecium* possesses more than 3,000 such units of cortical structure. Each unit is walled off by ridges, but is open internally. Had the boundaries been completed and each unit supplied with a nucleus, *Paramecium* would be a metazoan. Instead, the single central nucleus became highly polyploid, the unit boundaries in the cytoplasm remained open, and replication failed to achieve metazoan multicellularity.

The principle of replication followed by differentiation is not limited to this protozoan line of evolution. On one hand, it can be discerned on the smaller levels of organization. The preservation of new gene functions arising by mutation is facilitated by duplication of chromosome segments. The enormous variation in deoxyribonucleic acid seems to be based on replications of sequences of a few purines and pyrimidines with variations in the sequence. The variation in the backbones of proteins involves comparable replications and variations in the sequence of about two dozen amino-acid units. On the other hand, a similar principle appears also on larger levels of organization. The lowest multicellular organisms simply repeat a basic cellular unit; evolution of higher forms involves variation in these replicated units. Proceeding further, groups of cells form a unit which is repeated and varied, appearing as metamerism. Similar relations appear on up to insect and human societies where individuals and groups of individuals form the units that replicate and vary. From the molecular to the social levels, the same fundamental tactic of evolution is seen: repeat, then vary.

¹ Kalmus, H., "Paramecium, Das Pantoffeltierchen" (G. Fischer, Jena, 1931).

² Sonneborn, T. M., "Adv. Genet.", 1, 264 (1947).

³ Wichterman, R., "The Biology of Paramecium" (Blakiston, New York-Toronto, 1953).

⁴ Beale, G. H., "The Genetics of Paramecium aurelia" (Cambridge Univ. Press, 1954).

⁵ Sonneborn, T. M., *Heredity*, 4, 11 (1950).

⁶ Preer, jun., J. R., and Stark, Pearl, *Exp. Cell Res.*, 5, 478 (1953).

⁷ Lederberg, J., *Physiol. Rev.*, 32, 403 (1952).

⁸ Preer, jun., J. R., *Genetics*, 33, 394 (1948).

⁹ Dippell, Ruth V., *Heredity*, 4, 165 (1950).

¹⁰ Hanson, E., thesis, Indiana Univ. (1954).

¹¹ Chao, P. K., *Proc. U.S. Nat. Acad. Sci.*, 39, 103 (1953).

¹² Chao, P. K., *Microbiol. Genetics Bull.*, 11, 11 (1954).

¹³ Siegel, R. W., *Physiol. Zool.*, 27, 89 (1954).

¹⁴ Sonneborn, T. M., *Microb. Gen. Bull.*, 11, 24 (1954).

¹⁵ Sonneborn, T. M., *Microb. Gen. Bull.*, 11, 25 (1954).

¹⁶ Sonneborn, T. M., *Caryologia*, supp. vol., 307 (1954).

¹⁷ Fauré-Fremiet, E., *Rev. Suisse Zool.*, 60, 426 (1953).

¹⁸ Levine, M., *Evol.*, 7, 386 (1953).

¹⁹ Sonneborn, T. M., *Microb. Gen. Bull.*, 7, 22 (1953).

²⁰ Chen, T. T., *J. Morph.*, 79, 125 (1946).

²¹ Butzel, H. M., thesis, Indiana Univ. (1950).

²² Dippell, Ruth V., *Caryologia* (in the press).

²³ Jennings, H. S., *J. Exp. Zool.*, 97, 165 (1944).

²⁴ Sonneborn, T. M., *J. Prot.*, 1, 38 (1954).

²⁵ Jennings, H. S., *Biol. Bull.*, 86, 131 (1944).

²⁶ Nanney, D. L., *Proc. U.S. Nat. Acad. Sci.*, 39, 113 (1953).

²⁷ Kirby, H., *Rev. Soc. Mex. Hist. Nat.*, 10, 57 (1949).

²⁸ Ruff, A., "Problems of Morphogenesis in Ciliates" (John Wiley and Co., New York, 1950).

THE NATIONAL PHYSICAL LABORATORY

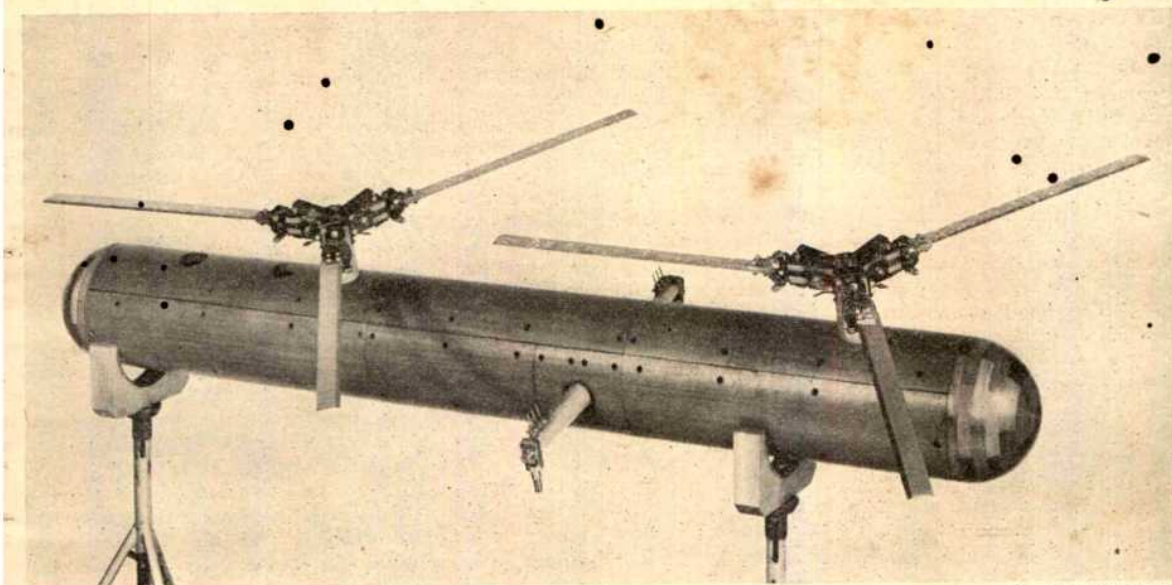
OPEN DAY

THE annual open day of the National Physical Laboratory took place on May 20. More than two hundred exhibits, nearly half of them new, were on view to two thousand two hundred guests of the Laboratory, representing industry, the universities and government departments, this record attendance being nearly twice that of last year. The General Board of the Laboratory held its annual meeting during the afternoon.

An item of topical interest was the commencement of a new research programme on helicopters. A tandem-rotor model 6 ft. long (Fig. 1) is at present being studied by the Aerodynamics Division in wind tunnel. The forward rotor of the helicopter fixed in position while the aft rotor can be moved longitudinally or vertically and its axis tilted fore and aft. The rotors are coupled together mechanically and driven by two 3-h.p. electric motors, housed within the helicopter body, at a maximum speed 1,800 r.p.m. producing a peripheral tip speed 400 ft./s. corresponding to a radial acceleration 2,340 *g*. To keep the masses of the blades as low as possible, they are made of hollow magnesium alloy with leading edges of brass, so that the centre of gravity of each blade is approximately coincident with its centre of pressure, thus reducing distortion in twist. To safeguard personnel in case of blade failure, the tunnel has been reinforced with steel plate.

Many of the difficulties encountered in high-speed flight with fixed-wing aircraft are due to flow separation from the surface of a wing either near the leading edge or at a shock wave lying farther aft. The Division is studying this phenomenon and has demonstrated the detailed observation of the flow around two-dimensional aerofoils at transonic speeds. The new 36 in. × 14 in. induced flow tunnel which operates up to a Mach number of 1.8 was shown. At present still being calibrated, this tunnel will be used for studying flow past aerofoils and the aerodynamic damping of oscillating wings. As the flow-separation parameters of aerofoils cannot, in general, be varied independently over a wide range, experiments are in progress on flow-separation induced by shock waves from flat and curved plates. This enables the conditions leading to flow-separation from unswept wings to be predicted and its effects understood. Swept-back wings present special problems, and detailed observations of flow are being made at high subsonic, transonic and supersonic speeds. Among the boundary-layer control techniques being investigated is the use of suction through a porous skin; an example of this on display in a low-speed tunnel was a body of revolution representing a fuselage with central section perforated to apply the suction.

The Control Mechanisms and Electronics Division displayed a magnetic storage drum, identical to that now fitted to the ACE pilot model digital computer which embodies an improved shift system to move sixteen pairs of heads into eight positions, so providing 128 tracks each 1,024 digits long. The drum is constructed of bronze coated with a tough 0.001-inch thick layer of magnetic oxide in epoxy resin. The high density of this coating results in excellent magnetic properties, so that one digit occupies only 0.012 in. square. Another device, which has been



Crown copyright reserved

Fig. 1. Tandem-rotor model helicopter being used for wind tunnel tests

developed for the British Coal Utilization Research Association, is a data processor fitted to a commercial self-balancing recorder so that the voltage at each of sixteen inputs is recorded sequentially by means of an automatic typewriter or a card puncher. The device contains a photo-etched brass disk, the etched portions of which are filled with insulating resin in contact with brushes which energize relays in a pattern dictated by the angular position of the disk.

The N.P.L. electronic simulator has been enlarged and is now available for use by industry. Its scope has been extended by the addition of a number of non-linear units including a general function generator.

Apparatus for the detection of atomic resonance in a caesium atomic beam was demonstrated by the Electricity Division. Based on the work of Rabi, a resonance at 9192.632 Mc./s. resulting from the interaction between nuclear and electronic spin is found by injecting a radio-frequency signal into a stream of caesium atoms focused sharply on to a slit by two magnets. Behind the slit the beam is detected by a hot tungsten wire which boils off the caesium as ions, producing a current which can be measured. At resonance the beam is de-focused, resulting in a fall of this ionic current. By using an exciting field normal to the beam, Doppler effect is eliminated; a high vacuum prevents broadening by collision while saturation is obviated by using each atom once only. Thus, as the Q of the system is 3×10^7 , the frequency of resonance should be determinable to better than one part in 10^9 and will be used for calibrating quartz standards of frequency and time.

The Light Division displayed a three-tier double trichromator consisting of three dispersive systems each similar to a van Cittert double monochromator with cancelling dispersions in the two stages. The systems are mounted vertically above each other, and a series of wedges enables the various intensities to be controlled. The trichromator is being used for a new determination of the colour-matching properties of the average eye with special attention to the differences between observations for small and large colour patches.

The Division is collaborating with the Metrology Division in experiments to determine the density of mercury to one part in 10^6 , an accuracy necessary to exploit fully the new primary standard barometer. Two hollow cubes with 75 mm. sides have been built up from fused quartz plates wrung together. The precision of manufacture of these plates is such that, before wringing, each face was flat to 0.1 fringe, and the angles within 0.2" of 90°. The volumes of the cubes will be known to one part in 10^6 . They will be filled *in vacuo* through a small capillary in the top plate and the mercury contents weighed to determine the density. This experiment supplements another determination based on the weighing in mercury of an equally precise solid cube of tungsten carbide of 3.5 in. face.

The Mathematics Division displayed DEUCE (digital electronic universal computing engine), an improved and engineered version of the ACE pilot model. This machine is the first of several being built by the English Electric Co. It uses the binary scale to represent numbers by trains of pulses generated at 1 Mc./s. Numerical data and instructions are injected from punched cards and the results recorded similarly, either in binary form for later computation or in decimal form for printing. It has high-speed mercury delay-line storage as well as a magnetic drum similar to that described above. The Division also demonstrated new punched-card equipment, including an electronic calculating punch which can multiply two 20-digit numbers together in a second.

The Metallurgy Division is investigating grain-boundary embrittlement. While studying the properties of pure iron, it was found that slight additions of certain impurities sometimes caused extreme embrittlement. Unlike the well-known effect observed in gold containing bismuth, there is no precipitation of a separate identifiable phase in the boundaries, and the magnitude of the effect depends on the heat treatment of the alloy. In the absence of any discrete phase, there is no complete explanation of the extreme embrittlement, but it

seems likely that some segregation of foreign atoms must occur; various techniques are being used in an attempt to detect it. The phenomenon of intergranular brittleness also occurs in copper-antimony alloys at both high and low temperatures with an intermediate temperature-range in which brittleness does not occur.

The Division has commenced a new investigation on the mechanism of fatigue. It is known that certain changes may take place in the lattice structure during fatigue, and attempts to detect such changes at an early stage in the process are now being made by focusing a fine beam of partially monochromatized X-rays on a small area in which repeated slip is occurring. Thin specimens are used permitting the photographic observation of the low-angle scattering of the transmitted beam. Initial observations on copper have shown a very characteristic low-angle pattern produced in conditions of fatigue, and this can be interpreted in terms of changes of density occurring in the slip plane.

A mechanical fiducial indicator for fitting to proving rings has been developed by the Metrology Division. This not only facilitates the setting of the micrometer screw but also shows at a glance if the deflexion is changing and thus indicates if the load is subject to vibration or creep. Although the wavelength of light is now used for many precise length determinations, line standards and scales are still of fundamental importance, and an investigation is proceeding on their intercomparison by photographic means. A graduation line is a shallow groove, and the density of its photographic image falls off gradually as one moves across it. However, the maximum change of density is well defined and is independent of both the characteristics of the emulsion and its processing. By observing the density gradient with a microphotometer, it is hoped to compare two standards to an accuracy of a few hundred thousandths of a millimetre.

One item of considerable contemporary importance was a comparator for measuring the pitch errors of the fir-tree-root serrations of gas turbine blades. The blades are mounted in such a way that measurement of the vertical heights above a datum formed by the lowest serrations gives the spacings rapidly and with high accuracy.

To meet the requirements of organizations doing research at low temperatures, the Physics Division is arranging to make liquid helium for them in its Collins cryostat. Up to 15 litres will be supplied in double 'dewars' cooled with liquid nitrogen, and the helium gas evolved in use collected for re-liquefaction. The Division has just completed the most comprehensive series of experiments yet conducted for the determination of equal-loudness contours for the human ear. This work was carried out at the request of the British Standards Institution, and the results should form an acceptable basis for a new standard in subjective acoustics.

Recent increased demand for heat insulation at low temperatures has resulted in the development of appropriate apparatus to measure the thermal conductivities of various materials. The heat flow is from a source at room temperature to a sink cooled by liquid nitrogen or solid carbon dioxide. Samples of materials such as fine fibred glass, expanded plastic and lightweight powder have already been tested.

The Ship Division demonstrated a new apparatus which determines the rate of saturation of air from

bubbles in water, information on this being required for the design of cavitation tunnels. Another new development is the use of radio-controlled models to study the manoeuvring characteristics of ships. The system demonstrated operates on a carrier frequency of 465 Mc./s. with nine audio channels each feeding a change-over relay. The relays control three star-wound repeater motors which drive the rudder and two selector switches controlling the speeds and directions of the two propulsion motors. The rate of operation of the shore controls is limited to scale speeds by centrifugal governors.

Midwives may now administer trichloroethylene B.P. as an analgesic with inhalers approved by the Central Midwives' Board, which issues a certificate of approval of satisfactory apparatus valid for six months. The National Physical Laboratory has undertaken the testing of the inhalers to the specification of the Medical Research Council, and the Test House has set up a new section for this purpose. Temperature-controlled boxes each hold four inhalers, and the trichloroethylene-air mixture is drawn from them by a special pump with an adjustable rate which simulates human breathing. For the high accuracy required, a Rayleigh refractometer is used for the volumetric analysis; other tests include the measurement of resistance to airflow and mechanical inspection.

A. J. GARRATT

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

OPEN DAYS

THE British Non-Ferrous Metals Research Association is this year celebrating the twenty-fifth anniversary of the opening of its own laboratory premises at Euston Street in London. The occasion was marked by a visit from H.R.H. the Duke of Edinburgh on May 23, and for the remainder of the week the laboratories were open to the representatives of member firms, government departments and others.

The original laboratory block in Euston Street was almost completely destroyed by enemy action during the Second World War; but it has since been rebuilt and now houses most of the Association's general metallurgy work and its metal-working plant. The laboratories have, however, been expanded considerably into adjacent blocks of buildings and now cover a floor area of about 43,000 sq. ft. and house a staff of about a hundred and fifty. The exhibition of work in connexion with these open days covered a very wide range of subjects, and in this short note it is only possible to refer to a few of those having a more purely scientific appeal.

For some years now the Association has been investigating the causes of the pitting corrosion of copper water-pipes which occurs in certain localities in Great Britain. Pitting corrosion is comparatively rare and usually affects only a few installations in any particular area. It has been found to be associated with cathodic films occurring under certain circumstances in the bore of copper pipes. The fact that pitting corrosion is rare is probably due to the presence of a natural inhibitor in many supply waters, and a great deal of work has gone into the separation of this inhibitor and in attempts to identify it.

The method of isolating the inhibitor consists in evaporating water under reduced pressure to produce a concentrate of the inhibitor. The inhibitor is precipitated from this as a copper salt, and a hydrochloric acid solution of this precipitate is extracted with ether. Distillation of the solvent leaves a crude concentrate of inhibitor which is then subjected to vacuum sublimation. Paper chromatography has been used for attempting to identify the constituents in this crude inhibitor and to compare these constituents with known substances. The stage has now been reached when substances reacting in the same manner as the extract of natural inhibitor have been shown to inhibit pitting corrosion of copper when added to water in quantities as small as the amount of natural inhibitor present in many water supplies.

Another interesting exhibit concerned the use of ion-exchange resins for analytical work. These are now being used extensively in the Association's laboratories for facilitating the analysis of electroplating solutions and for general metallurgical analysis. One example is the accurate determination of the amount of trivalent chromium in chromium-plating solutions. The method in common use involves titration of the hexavalent chromium of one sample and, after oxidation of another sample, titration of the total chromium. The trivalent chromium content is given by the difference between the two titrations, and this may sometimes be as little as 0.2 ml., so that small errors in measurement can easily give a misleading result. Using an ion-exchange column, the small amount of trivalent chromium present can be separated from the hexavalent chromium and titrated with ferrous ammonium sulphate of appropriate strength. The solution is passed through a column which retains the trivalent chromium. After washing the column with water to remove all the hexavalent chromium, the column is eluted with dilute sulphuric acid and the solution of trivalent chromium so obtained oxidized and titrated.

It is of interest to note that the laboratories have also recently built a demineralizing plant for the production of water for use in analytical work. The plant consists of an ion-exchange column with a mixed bed of anion- and cation-exchange resins. It will produce about 80 gallons of water between regenerations at the rate of about 10 gallons/hr. The water is purer than that obtained from ordinary laboratory stills, and running expenses are considerably below those of electric stills.

The mechanical testing section of the laboratories has recently developed a short-term fatigue test enabling a rapid assessment to be made of the endurance limit of many materials. The test is based on the Wöhler type of fatigue machine; but the load is applied by means of a spring. The load is gradually increased during the course of the test by extending the spring, using a slow-motion drive from the main drive of the fatigue machine, and the specimen is broken in a period which may range from four or five hours up to about a day. The extension of the spring at the moment of failure gives the 'dynamic breaking stress' for the specimen, and it has been found that, for lead alloys, copper alloys and steels, there is a direct correlation between this stress and the endurance limit of the material. The test is likely to expedite considerably the exploration of the fatigue properties of new materials.

The development of a non-destructive method for measuring the thickness of electroplated coatings has long been needed by the plating industry. This

problem has recently been solved in the Association's physics laboratory using a method based on a thermoelectric effect. A heated probe is applied to the surface of the electroplated specimen, and a cold probe is placed on the coating at some short distance away. The interface between the coating and the basis metal under each probe can be considered analogous to the hot and cold junctions of a thermocouple, and the e.m.f. generated is amplified and measured on a galvanometer. The reading obtained is proportional to the thickness of coating for any given coating-basis metal combination and, if necessary, the instrument can be calibrated to read directly in terms of coating thickness. Already several firms have made extensive field trials with the equipment, and arrangements have been made for two firms of instrument manufacturers to produce it commercially.

In the physics laboratory there has also been shown a method for vacuum-etching metallographic specimens, which is used where ordinary chemical or electrolytic etches have proved unsatisfactory. In this method the specimen is made the negative electrode and is etched at 1,000–4,000 V. in argon at a pressure of 1–100 μ of mercury. The etching time has been found to vary from fifteen minutes to several hours according to the nature of the specimen. It appears to yield particularly good results on some aluminium alloys, such as the aluminium–1½ per cent manganese alloy, and has also been used for revealing grain boundaries in copper which could not be seen by ordinary etching techniques.

One exhibit in the general metallurgy section of particular interest to the fundamental scientist concerns work which the Association is carrying out on the properties of grain boundaries. For this work bi-crystals of copper, the orientations of which with respect to each other are known, are being subjected to shearing forces tending to move one crystal relative to the other. The magnitude of these forces is such that at the test temperature plastic deformation of the crystals themselves is negligible. Optical interference methods are being used for tracing the relative movements of the crystals, and by this technique movements as small as 500 Å. can be observed. Eventually it is hoped that this work will give an indication of the part which grain-boundary movement plays in the behaviour of metals in slow creep.

THE WATER POLLUTION RESEARCH LABORATORY, STEVENAGE

THE Water Pollution Research Laboratory—one of the fourteen research stations of the Department of Scientific and Industrial Research—was set up in 1927. Until recently it had no permanent buildings of its own, and its work was carried out in a number of temporary laboratories in different parts of Britain. The official opening on June 20 of a permanent central laboratory at Stevenage therefore marks an important stage in the history of the organization.

In 1927 there were many urgent and serious problems of pollution of surface waters, particularly by industrial effluents, and indeed the organization was formed as the result of representations made at that time to the Lord President of the Council by a

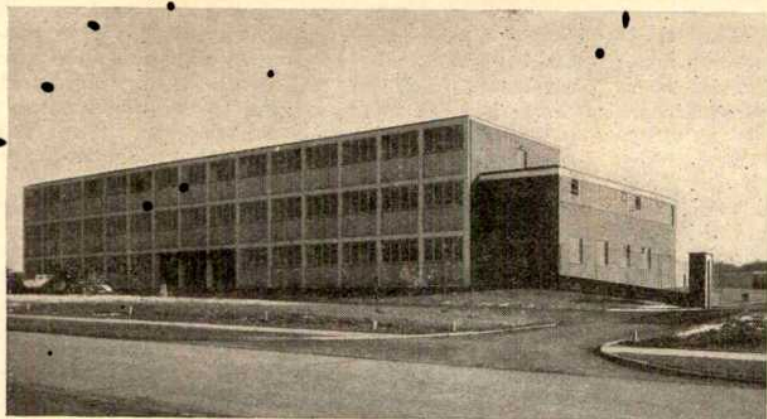


Fig. 1. Water Pollution Research Laboratory, Stevenage

parts of Britain for removing chromate, cyanide and toxic metals from effluents from the metal industries before these are discharged to sewers.

Since 1927 the view taken of pollution by industry has changed considerably, and it is now generally realized that it is essential in an industrial and thickly populated country such as Great Britain that rivers should be maintained in a reasonable state of purity. There has been a substantial increase in the volume of water distributed for domestic supply, and of this a large proportion is drawn from surface sources. Many of these sources have already received industrial and sewage effluents, and the cycle of

deputation representing water supply undertakings, medical officers of health, and fishery authorities. At first, therefore, the work of the organization was mainly on the development of methods of purifying particular industrial wastes; several years, for example, were spent in working on waste waters from the beet-sugar industry and from the milk industry, both of which were causing serious pollution in rural districts. In 1927 very little was known in detail of the effects of different types of polluting substances on fish, though it was clear that fisheries in many parts of Britain were rapidly being destroyed. Accordingly, during 1929-33 a survey of the estuary of the River Tees was undertaken; this was chosen as typical of several estuaries which had become impassable to migratory fish, and in which the numbers of salmon caught by anglers in the upper river and by net fishermen in the estuary itself were declining rapidly. As a result of this work, a better understanding was obtained of the effects on a fishery of directly toxic substances and of depletion of dissolved oxygen brought about by the oxidation by bacterial action of organic substances discharged as constituents of industrial wastes and sewage effluents. At that time, also, some local authorities were finding difficulty in purifying domestic sewage, as a result of the discharge to the sewers of industrial liquors containing substances which inhibited the microbiological processes on which the treatment of sewage very largely depends. The discharge of industrial wastes to domestic sewers—which is admitted to be on the whole a good policy—has increased considerably since the formation of the Laboratory, and a great deal of work has been done to determine the effects of important constituents on sewage treatment, and the maximum concentrations which can be tolerated. It is now becoming common practice in industry to remove particularly noxious constituents so that the remaining effluent can be treated in admixture with sewage without interfering unduly with the purification of the mixture at a sewage-disposal works. There are, for example, plants in many

discharge and re-use can only be operated if these liquids are effectively treated before discharge, so as to permit further natural purification to take place in the river, giving a water suitable for subsequent treatment at a water works. Industry is in much the same position, since the water supply of one factory commonly contains effluent from another factory—and often from a great many factories—discharged farther upstream. Since 1927, therefore, many industries, realizing the importance of effluent treatment, have themselves undertaken research, either at individual factories or through research associations. Examples of the kind of work done and of the success which has in many cases been achieved were given in a recent symposium organized by the Society of Chemical Industry (see *Nature*, 175, 790; 1955). It is an excellent thing that research on the treatment of an industrial effluent should be undertaken within the industry itself, since often the best and most economical solution is found, not by devising a method of treatment for a liquid already being discharged, but by modifying the processes of manufacture so as to reduce both the volume of the effluent and the quantity of material which it carries away with it to waste.

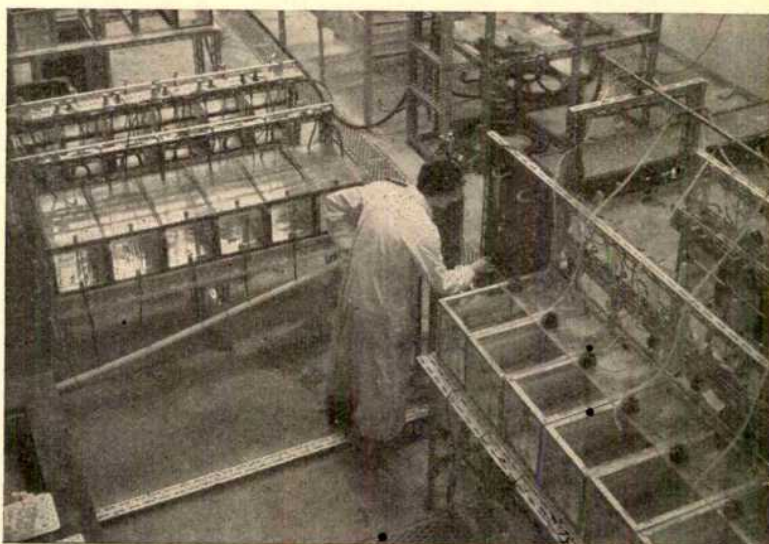


Fig. 2. Section of a pilot-scale laboratory for work on the effects of pollution on fish

The Water Pollution Research Laboratory is in close touch with much of the work of this kind which is carried out in Great Britain; but now that industry is taking an increasing part in the solution of its own problems, it is becoming possible to devote a bigger part of the resources of the organization to work of a more general and basic kind. The need for such work has become more important with the formation in 1948 of river boards with powers to lay down standards of quality of effluents which may be discharged into particular rivers. It is clear that before this can be done effectively, a river board must be able to predict, within reasonable limits, what will be the effect of discharging a given effluent on the general properties of a river—on its suitability, for example, for a domestic or industrial water supply or on its ability to support a fishery. To give an accurate answer to such a question requires much more information than is at present available on rates of oxidation of different substances in rivers, on the rate of absorption of oxygen by water from the air, on the effect of plants on the oxygen balance, on the long-continued effect of toxic substances on fish, and so on. This kind of long-range investigation is at present occupying a large proportion of the effort of the Laboratory. For example, a detailed study is being made of the conditions in the very polluted estuary of the Thames, some fifteen miles of which now contain no detectable oxygen in solution in dry weather. Here information is required on what the effect on this condition would be of changing various factors—for example, the input of oxidizable matter in sewage and industrial effluents, the temperature (which is appreciably raised by the discharge of cooling-water from power stations), and the fresh-water flow. Having studied, so far as possible, the components of the problem in the laboratory, the distribution of dissolved oxygen under present conditions has then to be predicted, taking into account the complex system of mixing and flow of fresh and salt water in an estuary. The validity of the data used in the calculations can be checked by comparing the predicted distribution of dissolved oxygen with the observed distribution; when it has been shown that the data used are reliable, it is then not unduly difficult to predict what changes will follow from altering any of the factors which affect the oxygenation of the water. On such information, it is hoped, future policy concerning the estuary will be based.

In collaboration with the Ministry of Agriculture, Fisheries and Food and the Freshwater Biological Association, a study has been begun of the effects of pollution on freshwater streams. Much of the information gained in the survey of the Thames Estuary—particularly on the factors which affect the oxygen balance—will be immediately applicable in this new work.

The present staff of the Laboratory includes chemists, physicists and biologists; usually these work in combined teams—an arrangement which is often of great mutual benefit. The new Laboratory was designed for a research staff (scientific officers and assistants) of about eighty-five; the present number is fifty-three. It has a floor space of about 40,000 sq. ft. and includes under one roof a three-storied block of which the top floor includes the library and office accommodation and the other two floors small-scale laboratories, and a single-storied wing containing four pilot-scale and associated analytical laboratories. One section of this wing is designed as a low-activity radiochemical laboratory.

In this, work is being carried out on the removal of radioactive substances from water; this section also undertakes for the rest of the Laboratory work involving the use of radioactive tracers. Two of the pilot-scale laboratories are specially designed for work with fish, and these are provided with a separate unchlorinated water supply from a bore-hole. A feature of the Station is that up to 70,000 gallons of domestic sewage can be pumped daily from a sewer crossing the site for use in large-scale experimental work in plant built in the open. The services are in general simple and orthodox; but where advantageous, use has been made of modern techniques and materials. Each laboratory contains an electrical circuit, operated from a master clock, from which impulses can be taken at intervals of 1 or 30 seconds; these operate relays and are widely used for marking time-scales and for controlling automatic apparatus. Another feature which has proved generally acceptable is that on suitable walls of each laboratory there are permanent metallic studs to which 'Dexion' or similar frame-work can be attached without boring holes in the wall. Distilled water is prepared centrally, using an automatic gas-fired boiler and a set of strip-action condensers in 'Pyrex' glass. Waste waters from the laboratories are drained through polythene waste pipes.

There is a transport section to assist in field-work, and metal-working and wood-working shops are provided for the construction of prototype apparatus designed and used in the laboratories.

OBITUARY

Prof. E. Regener

ERICH REGENER, who died on February 27, was born in Schleussensau near Bromberg on November 12, 1881. He studied physics under E. Warburg in Berlin, worked from 1909 onwards with H. Rubens at the Physics Department of the University of Berlin, and became, in 1911, professor of physics and meteorology in the Landwirtschaftliche Hochschule, Berlin. In 1920 he was appointed director of the Physics Department of the Technical High-school at Stuttgart, which, under him as experimental physicist, and with P. P. Ewald as theoretical physicist, soon became a lively centre of learning and research.

Regener is perhaps best known for his work on the intensity of cosmic rays under water and in the upper atmosphere. He was a pioneer in both fields, and at one time held both the depth and height records for cosmic-ray measurements: 230 m. below the surface of Lake Constance and 25 km. up in the atmosphere. These two achievements revealed his great experimental skill and ingenuity in the design of apparatus. Regener also made many important contributions to atmospheric physics, particularly in the study of ozone and of the physics of the crystallization of water.

During the Hitler regime, Regener had to resign his post at Stuttgart as his wife was a non-Aryan. However, he found support from the more liberal Kaiser-Wilhelm-Gesellschaft, as director of a laboratory at Friedrichshafen, for the investigation of the stratosphere. When, during the War, his laboratory was destroyed during an air raid, he built a small research station at Weissenau on Lake Constance, which, after the War, became part of the

Max-Planck-Gesellschaft. Both his children by his first wife (who died shortly after the War) had to emigrate as 'half-Aryan': his son Victor, also distinguished as a physicist, to the United States, and his daughter, married to the physicist Dr. Rathgeber, to Australia. After the War, Regener became a senator and vice-president of the Max-Planck-Gesellschaft.

Regener possessed exceptional personal charm and a wide liberal culture. He was both a good violinist and a keen yachtsman. His death means the loss to German science of a creative experimental physicist and one who, having weathered the devastation of the Hitler regime and of the War, afterwards did much to help to rebuild its great tradition.

P. M. S. BLACKETT

NEWS and VIEWS

Entomology at Rothamsted:

Dr. C. B. Williams, F.R.S.

DR. C. B. WILLIAMS, who has been head of the Department of Entomology of Rothamsted Experimental Station since 1932, retires on June 30. From Birkenhead School he went to Cambridge, where he took a science degree and the diploma in agriculture, and then to the John Innes Horticultural Institution, where he was one of Bateson's first research students. Between 1916 and 1927 he studied pests of sugarcane in the West Indies, and then pests of cotton in Egypt, where he was sub-director and then director of the Entomological Department of the Ministry of Agriculture. In 1927 he was appointed entomologist at the Amani Research Station in East Africa, where his work on locusts enhanced his already great interest in the migration of insects—a subject that has since continued to fascinate him and in which he has become one of the leading authorities. During 1929–32 he was Steven lecturer in agricultural and forest zoology in the University of Edinburgh, after which he was a visiting professor in the University of Minnesota before going to Rothamsted. In addition to continuing his studies on insect migration, at Rothamsted he has been concerned with problems of field ecology and the relation between weather and the activity of insects. He has been a pioneer in applying statistical methods to biology and has contributed much to knowledge on intra-generic competition and on the relative abundance of different species in wild populations of many kinds of organisms. Dr. Williams has been president of the Royal Entomological Society, the British Ecological Society and the Association of Applied Biologists. Aided by a grant from the Agricultural Research Council, he will continue his work on quantitative ecology at Kincaid, Inverness-shire.

Dr. Kenneth Mellanby, C.B.E.

DR. KENNETH MELLANBY, who is to succeed Dr. C. B. Williams, has until recently been principal of the University College, Ibadan. After taking the Natural Sciences Tripos at Cambridge, he did his first research at the London School of Hygiene and Tropical Medicine, starting to study insects and climate, a subject that has remained his main interest. In 1934 he was awarded the Wandsworth Fellowship and for two years worked on the tsetse fly in East Africa. Then, as the Sorby Research Fellow of the Royal Society, he went to the University of Sheffield, where he was appointed honorary lecturer in zoology. Here, in addition to studying the effects of environment on the behaviour of various insects, early in the War he undertook work on head lice and scabies. In 1943, as a major in the R.A.M.C., he conducted a casualty survey among prisoners of war in North Africa, and in 1944, as deputy field director of the

Medical Research Council Scrub Typhus Commission, he went to South-East Asia, where he was particularly concerned with organizing preventive measures against the disease. On his return to the United Kingdom, he was appointed reader at the London School of Hygiene and Tropical Medicine, a post he relinquished in 1947 to become the first principal of the new University College, Ibadan, where he also held the post of professor of parasitology. Since 1953 he has again been working at the London School of Hygiene, studying the manner in which insects can be acclimatized to withstand extremes of temperature.

Geology in the British Museum (Natural History): Mr. W. N. Edwards

MR. W. N. EDWARDS, who has been keeper of geology at the British Museum (Natural History) since 1938, is to retire on June 30. From the Cambridge County School he went to Christ's College, Cambridge, and was appointed to the Museum staff in 1913 as a palaeobotanist. He has travelled widely and collected fossil plants in many parts, and his published papers cover a varied range of palaeobotanical subjects. In the Department of Geology he has been particularly active in forwarding the publication not only of monographs and scientific papers but also of popular handbooks. He was a secretary during 1939–44 of the Geological Society, and recently he received the Lyell Medal of the Society. He is president this year of Section C (Geology) of the British Association.

Dr. E. I. White

THE Principal Trustees of the British Museum have appointed Dr. Errol Ivor White to succeed Mr. Edwards as keeper of the Department of Geology. Dr. White has been deputy keeper of the Department since 1938. Educated at Highgate School and King's College, London, he entered the British Museum (Natural History) in 1922, when he was given charge of the fossil fishes under the late Sir Arthur Smith Woodward. He has since specialized on the ostracoderms, and has published numerous papers on primitive vertebrates. He has collected fossils extensively in the Anglo-Welsh basin, and has also taken part in expeditions to Madagascar and Spitzbergen.

The Smithsonian Astrophysical Observatory

It is announced that the Smithsonian Institution and Harvard University will in future co-ordinate their programmes of astrophysical research. In pursuance of this policy, the headquarters of the Smithsonian Astrophysical Observatory will move to Cambridge, Mass., though some work will continue in the laboratories and workshops in Washington.

The two high-altitude solar observatories of the Institution, in Chile and on Table Mountain, California, will be maintained in operation. Prof. F. L. Whipple, who will succeed Mr. L. B. Aldrich on his retirement as director of the Smithsonian Astrophysical Observatory, will continue to hold his present post at Harvard College Observatory; and it is contemplated that the two bodies, though retaining their separate identities for administrative purposes, will eventually be staffed jointly.

The basic work of the Smithsonian Astrophysical Observatory from 1902 (twelve years after its foundation) to the present time has been the precise measurement of the Sun's output of radiation. This so-called 'solar constant' is a basic datum not only of solar physics but also of terrestrial meteorology. The early measurements of its magnitude were admittedly imperfect—the estimation of atmospheric absorption presents a formidable difficulty—but the instruments and the methods of observing have been steadily improved. Although the evaluation of periodicities in the variable energy output of the Sun and their correlation with terrestrial weather changes have been and are still controversial matters, there can be no doubt that the data accumulated at Washington and its field-observing stations during the past half-century represent a major contribution to the Institution's avowed purpose of "increasing and diffusing knowledge among men". The association of this work with that of the Harvard College Observatory, where solar research has also frequently followed a geophysical trend, promises well for the future study of solar-terrestrial relationships.

Mr. L. B. Aldrich

MR. L. B. ALDRICH retires from the directorship of the Smithsonian Astrophysical Observatory after forty-two years service with the Institution. Joining in 1913 as 'bolometric assistant', he worked in association with Dr. C. G. Abbot for the greater part of the latter's life study of the solar constant and of periodicities in its measured variations. He was appointed assistant director in 1930, and on Dr. Abbot's retirement from administrative work in 1944 he became acting director, being confirmed in the post of director a year later. During his long period of service, there have been issued from the Observatory not only the long reports containing the basic data from which the solar constant is derived but also a series of papers discussing the associated instruments and observational techniques, in the development of which Mr. Aldrich has often been personally concerned.

Prof. F. L. Whipple

PROF. F. L. WHIPPLE, who succeeds Mr. Aldrich as director on July 1, joined the staff of Harvard College Observatory in 1931, immediately after receiving the Ph.D. degree from the University of California at Los Angeles. He has done much basic work in high-speed ballistics and aerodynamics, particularly in connexion with the Harvard programmes of meteor study; in pure astronomy he has been interested chiefly in the physics of comets, of meteors and of interstellar gas. As professor, Dr. Whipple will remain a member of the council directing teaching and research in astronomy at Harvard. As director of the Smithsonian Astrophysical Observatory, he will join the Solar Associates, a group co-ordinating solar and upper-air research at Harvard and its Climax station with allied work by the U.S.

Air Force at Sunspot, New Mexico, and the Central Radio Propagation Laboratory of the National Bureau of Standards at Boulder, Colorado.

Physiological Research on Channel Swimmers

LAST year, when Butlins Ltd. organized a swimming race across the English Channel, two members of the Survival at Sea Committee of the Royal Naval Personnel Research Committee made a preliminary physiological examination of the participants and recommended that a fully organized research would be very valuable. As a result, for this year's race, which will be swum during August 10–16 by eighteen competitors, the Admiralty and the Medical Research Council are co-operating in such a full-scale investigation. The objects will be to determine so far as possible the effects of prolonged energy expenditure under cold immersed conditions and to study the biochemical changes which may arise; in particular, the fat distribution of each participant will be recorded before and after the swim. Each boat accompanying a swimmer will have on board a Royal Marines signaller, who will be in constant touch by radio with a Royal Naval vessel, Seaward Defence M.L. 3515, on which will be six scientific workers, and with two medical bases to be set up at Dover and Folkestone. The moment a swimmer gives up, the signaller will notify the scientific team and a research worker will immediately go and make an examination.

Scientific Needs of the Army

COMMEMORATION DAY was celebrated at the Royal Military College of Science, Shrivenham, on June 18, when a large company of past and present students attended with their guests and toured the laboratories. In an address given by Field Marshal Sir John Harding, Chief of the Imperial General Staff, he said that the Army needs a much higher standard of technical knowledge and that the general purpose of the College is to raise that standard and to make fashionable a technical outlook in the Army. Two other crucial needs are, first, that the Army's requirements are properly understood by research and development establishments and by producers and, secondly, that the Army knows what science has to offer. The War Office, in conjunction with the Ministry of Supply, is to set up a special selection board to deal with the planning of the careers of technical staff officers.

Research and Development in the Coal Industry

IN referring to the report of the Advisory Committee on the Organization of the National Coal Board (*Nature*, May 21, p. 867), attention was directed to the recommendation that a research and development committee should be set up. The National Coal Board has now established a Technical Research and Development Committee consisting of J. Bowman (deputy chairman of the Board), J. Latham (finance member), Dr. W. Reid (production member) and A. H. A. Wynn (scientific member). The director-general of research (Dr. Idris Jones) and other senior officials of the Board attend the Committee by invitation. The terms of reference of the Committee are as follows: "To consider and approve, in the form of programmes and budgets, the general lines of the Board's research and development in the Production and Carbonization fields, having regard to the weight of effort to be directed to the various elements in the programmes and the

degree of priority which should be given to them; to receive progress reports; and to ensure that work on all the items in the approved programmes is properly and promptly carried out; and that useful technical information that is obtained is adequately disseminated".

On the wider issues of training for management, the Board has now appointed Mr. N. G. Fisher to be principal for its proposed Staff College, and search is being made for suitable premises. In the meantime, courses for colliery managements, as well as for some of the technical staffs at the area and divisional offices, are being run at temporary accommodation. The recruitment and training of staff are being further strengthened by the creation of a Staff Department at headquarters under Sir Andrew Bryan (staff member of the Board); and four staff directors have already been appointed to divisional boards.

Natural Gas near Crowborough, Sussex

As part of the Gas Council's five-year search for natural gas in Great Britain, a second deep well is to be sunk in the area near Crowborough, Sussex, about a mile south-east of the first well. The arrangements are in the hands of the D'Arcy Exploration Company (a member of the B.P. group), which is undertaking the work on behalf of the Gas Council. The first well in the area, which has been carried down to a depth of about 4,500 ft., has revealed small shows of gas at several levels, and the results obtained from it, and from subsequent seismic surveys in the area, indicate that a further deep test is justified.

The Institute of Biology

THE Institute of Biology, now in its sixth year of existence, has elected as president Sir James Gray, who was one of those concerned with the initial moves which led to the foundation of the Institute and a vice-president during 1950-54. New council members for 1955 have been elected as follows: Prof. G. E. Blackman, Mr. N. W. Pirie (*vice-presidents*); Dr. N. E. Hickin (*honorary treasurer*); Mr. H. J. Bunker, Dr. R. J. C. Harris, Mr. F. R. Horne, Dr. A. S. Parkes, Dr. C. L. Smith. Honorary membership has been conferred on Lord Boyd Orr and Sir John Russell in recognition of their services both to biology and to the application of biology to the betterment of mankind. The membership of the Institute is now: 1,150 full members, 60 probationer members and 290 student members. The steady growth of membership has enabled the Institute to establish regional branches and to undertake an increasing range of activities. Further information about the Institute can be obtained from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Bibliography of Natural History

A RECENT issue of the *Journal of the Society for the Bibliography of Natural History* (3, No. 2, 63; 1955) includes a number of items of considerable interest to scholars, including an address on the "Bibliography and the History of Science" by V. A. Eyles, and an important classified list of books of reference and bibliographical books on zoology by F. C. Sawyer, comprising the works of some 212 authors. V. A. Eyles also contributes a note on the earliest printed version (1788) of the "Theory of the Earth" by James Hutton.

Natal Museum (1904-54)

THE March number of the *South African Journal of Science* includes an article on the golden jubilee in 1954 of the Natal Museum. The Museum was originally sponsored by the Natal Society, which was formed in Pietermaritzburg in 1851. The Society soon acquired museum objects, which were moved from site to site until the final move was made to the present premises in Theatre Lane. Eventually it became evident that the Museum had outgrown the resources of the parent body, and the Government assumed responsibility in 1904. A series of functions was arranged to commemorate this event, the most notable being a gathering on November 30, 1954, in the Museum. An illustrated brochure on the history and development of the Museum has been published.

Oundle School Natural History Society

A FINE example of voluntary effort is the report of the Oundle School Natural History Society for 1954. Apart from its varied contents, the printing, duplicating and reproduction of photographs in the report have been tackled with enthusiasm and have led to a publication which will undoubtedly give pleasure to all who study the natural history of Northamptonshire. Besides the usual notes recording observed fauna and flora, the report contains a short article on the emergence of the hornet clearwing moth, an account of butterfly-collecting in the south of France and northern Spain and of some Welsh beetles, and a description of the distribution of *Spurvorbis spirillum* and *S. borealis* on the shore at Millport.

Discovery

THE latest issue of *Discovery* (26, No. 4; April 1955) contains the usual series of articles on varied aspects of science which are of topical interest and which have been written for the intelligent layman and for the man of science who wishes to keep himself informed of developments in other fields. Among them is an account by Dr. G. Curzon of mescaline and its physiological and psychological effects. The development of automatic factories is described by Dr. S. Lilley, who gives some details of the sequence of operations in the automatic production line at a Moscow piston factory. Prof. C. M. Yonge has written an illustrated article on giant clams, while R. G. Rose contributes a short description of the life of Carl Frederick Gauss. There is also an interesting article by James Paton explaining how the Observatory on Ben Nevis came into being and fell into decay.

The Science Masters' Association

THERE can be few voluntary organizations which, over a period of thirty-two years, are able to show a steady rise in membership each year. Despite the Second World War, the Science Masters' Association showed a steady increase in membership from 364 in 1919 to 4,540 in 1952. In 1953 there was a slight decline in membership; but it is pleasing to note in the annual report for 1954 that membership again showed an upward trend. The contribution made by this Association to the quality of science teaching in schools by means of regular meetings, an annual conference and the publication of its excellent journal, the *School Science Review*, is immeasurable. Among special items referred to in the report are the inquiry made by the Association into the deterioration of science teaching caused by the shortage of science masters; the findings of a sub-committee on

science teaching in secondary modern schools; and reference to an investigation into the present and future supply of laboratory assistants. The Association also has a Chemistry Teaching Aids Sub-Committee which makes contacts with industrial organizations willing to produce material for use in schools.

Manchester Literary and Philosophical Society: Officers:

The following have been elected officers of the Manchester Literary and Philosophical Society: *President*, Dr. P. F. R. Venables; *Vice-Presidents*, Miss A. C. Alexander, Sir Geoffrey Jefferson, Prof. J. Kenner and Dr. Norman Smith; *Honorary Secretaries*, G. F. Clayton and F. Willett; *Honorary Treasurer*, H. Hayhurst; *Honorary Librarians*, Dr. W. H. Brindley and Dr. L. Cohen; *Honorary Curator*, Donald Stephenson.

National Research Council of Canada: Awards for 1955-56

THE National Research Council of Canada has made 267 awards for 1955-56, totalling 336,300 dollars in value. They include 62 bursaries (800 dollars each), 133 studentships (1,100 dollars) and 18 fellowships (1,400 dollars), all of which are to be held in Canada. Of the awards for study abroad, thirty-three special scholarships, worth 1,900 dollars each, have been granted which will be held in the following countries: nineteen in the United Kingdom, eleven in the United States, and one each in France, Sweden and Denmark. Twenty-one overseas postdoctorate fellowships at 2,500 dollars each have been granted for work in the following countries: fifteen in the United Kingdom, two in The Netherlands, and one each in Sweden, Denmark, France and Belgium.

The Night Sky in July

FULL moon occurs on July 5d. 05h. 28m., v.t., and new moon on July 19d. 11h. 34m. The following conjunctions with the moon take place: July 18d. 04h., Mercury 0.1° S.; July 27d. 19h., Saturn 6° N. In addition to these conjunctions with the moon, Mars is in conjunction with Jupiter on July 24d. 22h., Mars 0.6° N.; Venus with Pollux on July 27d. 08h., Venus 6.2° S.; and Mercury with Pollux on July 27d. 15h., Mercury 5.8° S., and also with Venus on July 28d. 01h., Mercury 0.3° N. Mercury rises in the early morning hours at 3h. 05m., 2h. 40m. and 3h. 45m. on July 1, 15 and 31, respectively. Its stellar magnitude varies between 1.6 and -1.5, the visible portion of its illuminated disk increasing from 0.173 to 0.959 and its distance from the earth varying from 66 to 121 million miles. As already noted, it approaches the moon very closely on July 18. Venus is visible in the early morning hours, rising at 2h. 45m., 3h. and 3h. 35m. at the beginning, middle and end of the month, respectively. The visible portion of the illuminated disk remains almost the same, the variation being 0.955-0.988 and the stellar magnitude changing from -3.3 to -3.4. Mars sets less than an hour after sunset on July 1 and is too close to the sun during the month for favourable observation. Jupiter, which is in conjunction soon after the end of the month, is too close to the sun for favourable observation. Saturn sets at 1h. 05m., 0h. 10m. and 23h. 05m. on July 1, 15 and 21, respectively, its stellar magnitude being 0.7-0.8; and its distance from the earth increasing from 863 to 905 million miles. Only one star of

magnitude brighter than 6 is occulted in July: 4744 reappears on July 11d. 0h. 13.5m., +1°, mag. 5.6 (observation being made at Greenwich). The sun is in aphelion on July 4.

Announcements

PROF. J. H. OORT, professor of astronomy in the University of Leyden, has been elected a *correspondant* for the Astronomy Section of the Paris Academy of Sciences in succession to Sir Harold Spencer Jones, recently elected a foreign associate of the Academy.

PROF. L. DUDLEY STAMP, professor of social geography in the London School of Economics and Political Science, has been awarded the honorary degree of LL.D. by Clark University, Worcester, Massachusetts. The Graduate School of Geography at Clark University, now headed by Prof. S. Van Valkenburg, has long held a leading position in the United States, and for the past thirty years has published the quarterly journal *Economic Geography*.

SIR ROGER DUNCALFE, president of the British Standards Institution, has been elected president of the International Organization for Standardization and will hold the office for three years from January 1 next. Besides his national and international work on industrial standards, Sir Roger is closely connected with chemical industry, being chairman of British Glues and Chemicals, Ltd.

THE Shell Petroleum Co., Ltd., is to award annually to students in Canada two postgraduate scholarships in science or engineering similar to those already given by the Company to students in other countries of the British Commonwealth. The scholarships are worth £750 a year for two years of study in the United Kingdom leading to a higher degree. The first two awards have now been made to the following for study as shown: T. P. Schaefer (University of Manitoba), physical chemistry in the University of Oxford; and G. E. Chadwick (University of British Columbia), nuclear physics in the University of Cambridge.

An exhibition of radiological defence instruments will be held during June 28-29 in the Palais de Chaillot, Paris, the headquarters of the North Atlantic Treaty Organization, in conjunction with the forthcoming first session of the Civil Defence Committee. Several countries will be showing their equipment, and the British contribution to the exhibition is considerable, with sixteen individual manufacturers participating. A catalogue of the British exhibits, printed in English, French, German, Spanish and Greek, has been prepared and is available on application to R. H. Cooke, X-Ray Division, Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, from whom further information can be obtained.

An exhibition of scientific instruments and apparatus of Continental manufacture is being held by Hudes Merchandising Corporation, Ltd., Charter House, 52 Gloucester Place, London, W.1, during June 28-July 9. Among the exhibits are balances by Sartorius-Werke, a flame photometer from Dr. Lange of Berlin, a complete range of electrophoresis and chromatographic apparatus from L.K.B. Produkter of Stockholm, the Sjöstrand ultramicrotome, some new electrically heated porcelain apparatus, glass apparatus by Schott and Genossen, interference filters and a range of Zeiss microscopes and accessories.

PERSONAL FACTORS IN ACCIDENT PRONENESS*

STUDIES of accident proneness are usually either statistical or psychological. The statistical studies have inherited common aims and methods from the pioneer work of Greenwood and Woods¹. The psychological studies have been diverse in aim, ranging from attempts to predict the accident prone by aestheto-kinetic skill test performance, through other investigations of a laboratory type seeking to define the behaviour inadequacies responsible for accidents, to clinical assessment of various aspects of the personality of multiple accident-prone individuals. Dr. J. A. Smiley's work belongs to the last-named class, although he gives due place to earlier work along the other approaches. He has made full use of his position as medical adviser to an aircraft-manufacturing company to study the accident histories of 6,450 men, and to examine in detail eighty-seven men classified as accident prone, and a random control group of a hundred normal men.

His thesis may briefly be stated—accident-prone individuals are usually emotionally disturbed, with associated hypothalamic misfunction which, it is tentatively suggested, produces minor imbalance of adrenalin and acetylcholine with concomitant behaviour disturbance. This thesis needs to be examined both in the light of the evidence he presents, and in respect of other studies.

There can be no doubt that a large proportion of his eighty-seven cases were emotionally disturbed. The evidence, presented soberly and cautiously, may almost be described as overwhelming. The case-histories are illuminating; classification on Culpin's scale (with a high degree of care exercised against possible observer bias) shows that 72 per cent of the accident group exhibit emotional disturbance of a marked degree, against 8 per cent of the normals. The accident-prone individuals also show 'anxiety' sweating in interview, albumin in the urine specimens collected during medical examination, a seven-fold increase in peptic ulcer incidence, and a more than four-fold increase in incidence of other medical symptoms. There can be little doubt as to the accuracy of the psychiatric diagnoses of these men.

The problem remains, however, whether these men may adequately be described as accident prone. Dr. Smiley is cautious in pointing out that his conclusions may only apply to men engaged on similar work and (as he specifically states) would not apply to road accidents. His introductory statistical observations (which are, unfortunately, marred by errors—his tabulations of observed accident frequency give a total incidence of 13,584, against a quoted 14,498, the latter figure being used for the theoretical distributions) do not completely comply with the canons of statistical investigation. Although the men all work in shops of roughly equivalent risk per hundred thousand man-hours, no check has been made of each individual's actual exposure, which, of necessity, will vary with the total number of hours worked. It is also very likely that there are large differences in actual risk due to differences in work done within the larger occupation groups. The eighty-seven cases picked out are, however, so removed from their fellows that these points are probably of

minor importance. A more serious objection is that only minor injuries are considered. To some extent this must have been inevitable, as apparently only 1 per cent of injuries reported involved absence of more than one day. Greenwood and Woods's dictum that the law of a distribution will not in general be affected by the consequences of the result is quoted in extension of this use. But the correlation between minor and major accidents, though positive, is not usually very large, and accident proneness, as an important problem, concerns those incidents with more severe medical, human and economic sequelæ. Dr. Smiley's accident group attended the medical room for accident injury treatment approximately six times as often as average. They also attended for other medical purposes approximately two and a half times more than normal. Taken in consideration with the sweating, albuminuria and peptic ulcer incidence, the main conclusion to be drawn is that proneness to report minor injury can be added to the list of other known clinical signs of emotional disturbance. This is valuable; but when Davis² has reported that a group of accident-prone coalminers (who had sustained many 'disabling' accidents) showed no similar symptoms, it would suggest that accident proneness, as distinct from proneness to attend the surgery whatever the reason, has still to be described in psychological or psychiatric terms.

J. W. WHITEFIELD

¹ Greenwood, M., and Woods, H. M., "The Incidence of Industrial Accidents with Special Reference to Multiple Accidents". (Medical Research Committee, Industrial Fatigue Research Board Report No. 4.) (London: H.M.S.O., 1919.)

² Davis, D. R., *Quart. J. Exp. Psychol.*, 1, 136 (1949).

SECONDARY ELECTRON EMISSION

A COLLOQUIUM on "Secondary Electron Emission", sponsored jointly by the Institute of Physics and the Physical Society as one of a series of meetings on electron physics, was held in the lecture theatre of the Institute on March 1, when eight papers were read and discussed. This report summarizes first the papers on secondary emission yield, on energy losses and on depth of penetration of electrons, and is followed by a résumé of the talk by Prof. H. Fröhlich (University of Liverpool), who spoke on the quantum theories of secondary emission. The succeeding papers deal with phenomena exhibited by specific targets.

S. Rodda (Edison Swan Electric Co., Ltd., Enfield) spoke briefly on universal curves for secondary emission yield, a subject in which we are greatly indebted to Bruining and Jonker. The formulæ proposed assumed δ to be of the form

$$\delta = \frac{aV^n}{1 + bV^m}$$

in which the relative yield curve would be

$$\Delta = \frac{\frac{m}{m-n} W^n}{1 + \frac{n}{m-n} W^m}$$

with $\Delta = \delta/\delta_m$, $W = V/V_m$.

* Substance of the Milroy Lectures of the Royal College of Physicians of London, given by Dr. James A. Smiley on Feb. 8 and 10, 1955.

Kadyshevich has given an equation of the form,

$$\Delta = \frac{2W}{1 + W^2}$$

but this falls away too quickly when W is high. Good agreement with the experimental results collected by Jonker exists if Δ is put equal to

$$\frac{3W}{1 + 2W^{3/2}}$$

or with the results of Brophy if

$$\Delta = \frac{2W^{1/2}}{1 + W}$$

The latter also matches well a complicated equation for Δ , derived by Rodda, assuming three things: the depth of penetration of primaries proportional to their energy at incidence; the probability of creation of a secondary electron inversely proportional to the primary velocity at depth x to $(x + dx)$; and the probability of escape from a depth x to be proportional to $x_0/(x_0 + x)$. (It may be remarked that Dr. Bruining's results quoted below do not invalidate the first assumption, if reflected primaries from the molybdenum substrate return to a large minimum depth from which the ejection of secondaries is detectable.)

The second paper, on the secondary-emission coefficient of the elements, was by D. A. Wright (Research Laboratories, General Electric Co., Ltd., Wembley), who first sketched the attempt made by Sternglass in 1950 to relate δ_m to the position of the element in the periodic table. Wright has replotted the available values of δ_m against atomic number, and the graph clearly shows a break at sodium which he expected, and confirms the rise at the end of the second part of the long period which was shown by Sternglass. "This rise corresponds with a similar rise in both work function and ionization potential." Wright has been particularly interested in the correlation of δ_m with work function, and showed that δ_m increases with ϕ with a definite, almost linear correlation between their values. Finally, it was shown that better correlations appear if one plots work function and secondary emission against the reciprocal of the distance (d_0) of closest approach of the atoms in a solid, instead of against the inverse cube root of the atomic volume. The values of δ_m and ϕ then follow "one main line, a parallel line for the second period and higher lines for the second parts of the long periods". The behaviour can be understood if the scattering and energy-losses of the secondary electrons are, in fact, independent of d_0 .

In his paper on the characteristic energy-losses of electrons in solids, Dr. D. Gabor (Imperial College of Science and Technology, London) reported on the collective interaction of metal electrons with fast electrons, first suggested by D. Bohm and D. Pines. This process can be conceived in much the same way as the interaction of X-rays with solid lattices in Bragg's interpretation, that is to say, as reflexions by the Fourier components of electron density.

Experiments recently carried out by D. Gabor and G. W. Jull have supplied evidence that the characteristic energy-losses first observed by Rudberg, Farnsworth and, in particular, by Ruthemann are due to collective interaction. The losses in solid layers of gold 100–200 Å. thick were compared with stratified sheets built up in layers of 30 Å. each, with thin layers of carbonaceous contamination between. The stratified layers did not show characteristic

losses, so that these cannot be due to interactions with single atoms. The theory of collective interaction explains this, because in stratified sheets only those vibration modes exist which give zero current at the boundary at every stratum, and so there are fewer vibrational modes than in a solid layer. The experiments suggest that plasma waves with wavelengths less than 30–50 Å. are strongly damped.

The next paper, by Dr. H. Bruining (Philips Research Laboratories, Eindhoven), dealt with some experiments on the depth of penetration of electrons in thin beryllium layers. The experiments were undertaken to find the range of primary electrons by measuring the secondary emission yield of targets consisting of different components, and in the particular experiments described, which were carried out by Nienhuis of the Philips Laboratories, successful results were obtained by evaporating layers of beryllium on to a molybdenum substrate. It is essential that the secondary emission yields of the two materials chosen shall differ widely, and this is fulfilled, since δ_m for beryllium is 0.6 and δ_m for molybdenum is 1.5. At first the secondary emission yield rises when a thin, presumably monatomic layer of beryllium is evaporated on to the molybdenum; but with thicker layers δ becomes characteristic of the evaporated metal below some critical voltage V_p of bombardment, while above V_p there is a divergence. V_p varies with the time of evaporation and therefore with the thickness of the deposited metal. At first sight it would seem that the thickness of the metal is that which is just penetrated by primary electrons of energy eV_p . The curve for the thickness d , plotted against V_p , can be represented by the square law equation $d = V_p^2/a$, where a has the value 0.8×10^{12} V.²/cm., in remarkable agreement with the value 0.75×10^{12} V.²/cm. determined by Whiddington for beryllium.

Calculations which Dr. Bruining gave showed, however, that the absorption of secondary electrons originating in the molybdenum would be so strong in the beryllium layer that none could reach the target surface; the observed rise in δ should be ascribed to the reflexion of fast primaries from the interface, or to the enhanced generation of secondaries in the beryllium layer which the reflected primaries would cause. In the latter case, too, only the additional secondaries produced in a very thin surface layer of the beryllium could escape. Thus the argument shows that the incident electrons must have travelled back and forth through the beryllium layer, which means that the range was twice the thickness of the layer and so a equals 0.4×10^{12} V.²/cm. instead of 0.8×10^{12} V.²/cm.

The results were compared with those of Copeland in 1940, when targets of aluminium covered with platinum were investigated, and showed a linear relation between depth of penetration and V_p up to 500 V., tending to a parabolic shape at high values of V_p . The difference may be due to the difference in atomic structures between the simple beryllium and the more complicated shell of platinum, where more electrons could interact with a primary electron as its energy is increased.

When Prof. Fröhlich spoke on the theory of secondary electron emission from solids, he made it clear that none of the recent attempts to develop a theory of secondary emission from solids is physically correct. It is not permissible to represent the wave functions of the valency electrons by plane waves when the collision processes involve large changes in

energy. Prof. Fröhlich proposed to use the Weizacker-Williams (1935) method to calculate the rate of loss of energy of a particle in a solid. The primary particle is replaced by a moving point charge e , having velocity v_0 , and its time-dependent field is developed in its Fourier components with respect to time. If the optical properties of the solid are expressed in terms of a complex dielectric constant

$$\varepsilon(\omega) = \varepsilon_1(\omega) + i\varepsilon_2(\omega)$$

it is shown that (cf. Fröhlich and Platzmann, 1953)

$$-\frac{dW}{dt} = \frac{2e^2}{\pi v_0} \int_0^\infty \frac{w \varepsilon_2(\omega)}{\varepsilon_1^2(\omega) + \varepsilon_2^2(\omega)} x K_0(x) K_1(x) d\omega$$

where W = energy of the particle, v_0 = velocity of the particle, $K_0(x)$ and $K_1(x)$ are modified Bessel functions of the second kind, of order zero and 1, and $x = \omega \rho_{\min}/v_0$, $\rho_{\min}$ being the smallest value the collision parameter can take. This value has to be determined from independent considerations and usually occurs in the final result only logarithmically.

Further calculations (which can be reproduced in this article only in condensed form) show that there must be a close connexion between photoelectric and secondary emission in a solid. Let

$$P(\mathbf{v}, \omega) dv_x dv_y dv_z$$

be the rate of emission of photoelectrons with velocity $\mathbf{v}$ in a range $dv_x dv_y dv_z$ if the electric displacement in the solid is such that its square is $D_\omega^2 d\omega$ in a range near ω . Then a function $f(\mathbf{v}, \omega)$ can be found such that

$$P(\mathbf{v}, \omega) = f(\mathbf{v}, \omega) D_\omega^2$$

and if $Q(\mathbf{v}) dv_x dv_y dv_z$ is the rate of emission of secondary electrons of velocity $\mathbf{v}$ in the range $dv_x dv_y dv_z$, it follows that

$$Q(\mathbf{v}) = \int f(\mathbf{v}, \omega) D_\omega^2 d\omega.$$

Now primary electrons of velocity v_0 crossing the surface at the rate of n per second per unit surface area create an electric displacement in an (isotropic) solid such that

$$D_\omega^2 d\omega = \frac{2}{\pi} \frac{e^2}{v_0^2} n d\omega x K_0(x) K_1(x)$$

so that $Q(\mathbf{v}) = \frac{2}{\pi} \frac{e^2}{v_0^2} n \int_0^\infty f(\mathbf{v}, \omega) x K_0(x) K_1(x) d\omega$.

To turn now to the phenomena exhibited by fabricated targets, Prof. J. D. McGee (Imperial College of Science and Technology, London) read an interesting paper contributed by Prof. W. G. Shepherd and P. Wargo (University of Minnesota) on the preparation of thin-film magnesium oxide secondary-emission targets and some of their properties. In their laboratories a secondary-emission ratio of the order of 12 at 500–700 V. primary energy has been obtained by baking the electrodes *in vacuo* at a pressure less than 10^{-4} mm. of mercury and then heating the alloy to 750° C. brightness in dry oxygen at a pressure of 10–20 microns.

The silver does not directly contribute to the properties of the ultimate magnesium oxide film; but during the preparation it governs the diffusion of magnesium to the surface, and the detrimental counterflow of oxygen diffusing into the silver, where it would react internally with the magnesium to form

magnesium oxide. The magnesium diffusing to the surface may be oxidized there, or with low oxygen pressure lost by evaporation. It is possible to inhibit the diffusion of oxygen into the alloy by plating thereon a layer of nickel one micron thick, and Rappaport has successfully used gold. Satisfactory results were also obtained with a dry carbon dioxide atmosphere. The authors also considered the effects of evaporation materials from an oxide-coated cathode; by using a radioactive tracer technique it was found that barium was evolved about ten times faster than strontium, almost certainly as barium oxide. An experimental system was then described whereby barium oxide can be evaporated on to a silver magnesium target, the thickness determined by a tracer method, and the secondary emission yield measured.

With very thin layers of barium oxide on magnesium oxide, the effect is to increase δ , which becomes a maximum when the layer is between one and two molecules thick. When δ is plotted against evaporated film thickness, the curves exhibit a break for a thickness of thirty molecular layers for each energy, which suggests that the depth of escape of the secondary electrons controls the yield rather than the depth of penetration of the primary electrons. In further studies on thin magnesium oxide films it was concluded that an overlayer of barium oxide would protect magnesium oxide from erosion under electron bombardment, and as an example it was shown that the time required for δ to fall to 80 per cent of its original value rose from 8 hr. with the uncoated magnesium oxide target to 190 hr. with a similar target with a barium oxide coating eight molecular layers deep.

Dr. J. Woods (Research Laboratories, General Electric Co., Ltd., Wembley) reported on the studies he had carried out on the mechanism of secondary-emission decay processes. Barium oxide films were chosen since δ decays rapidly under electron bombardment and the physical properties of barium oxide are well known. Experiments show that the oxide decomposes under bombardment, and that the free barium formed is responsible for the reduction in δ ; in fact, the oxygen moves outwards towards the surface while an excess of barium accumulates in the penetrated region of the oxide. A film in which an excess of barium is created in this way can be brought to give its original δ by oxidation. The reason why an excess of barium is detrimental is due to the coagulation of barium into colloidal particles which act as very efficient electron traps.

Thick evaporated films of barium oxide exhibit a blue luminescence when bombarded with 240-V. electrons, and when δ decays the luminescence decays also. The behaviour of a zinc-cadmium sulphide phosphor under electron bombardment shows many analogies, and it is suggested that the phenomenon of electron burn is due to colloidal metal formed in the bulk of the sulphide.

In a final short paper, R. M. Payne (Associated Electrical Industries, Aldermaston) described electron diffraction investigations on the electropolished surfaces of beryllium-copper and a beryllium-copper alloy containing cobalt. These materials had been used for a demountable secondary electron multiplier. An extremely compact multiplier with beryllium-copper electrodes was shown by Dr. R. H. M. Lamb (Cavendish Laboratory, Cambridge) as one of many possible examples of the technical importance of "secondary electron emission".

S. RODDA

PEPTIDE CHEMISTRY
CHEMICAL SOCIETY SYMPOSIUM

ON the occasion of the recent anniversary meetings in London of the Chemical Society, a symposium on peptide chemistry, arranged by Prof. D. H. Hey, was held on March 31 at the Royal Institution. The symposium consisted of five papers, two on physico-chemical aspects of the problem (Prof. H. D. Springall in the chair), and three on organic chemical aspects (Prof. Hey in the chair). A full account of the symposium will be issued as a special publication of the Chemical Society. The proceedings were opened by Prof. W. Wardlaw, president of the Chemical Society.

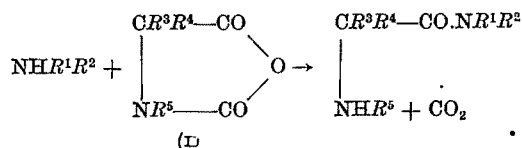
The first paper was by Prof. K. Linderstrøm-Lang (Carlsberg Laboratories, Copenhagen), who described some of his recent work on deuterium exchange between peptides and water. From earlier work it appeared likely that the rate of deuterium exchange in peptide systems would vary with the accessibility of the replaceable hydrogen atoms and the extent to which they are involved in hydrogen-bonding. In the present work, the quantitative study of rates of deuterium exchange has been applied to peptide systems of varying complexity and the results correlated with the structure of the peptides.

The experimental techniques were described. These depend on cryosublimation at -60°C. , and density determinations, in the gradient tube. The results are as follows: Single-chain peptides, lacking intra-chain disulphide bridges, undergo immediate and complete exchange at 0° (alanylglycine, leucyltriglycine, oxidized insulin A-chain, oxidized ribonuclease). In the case of ribonuclease, this 128-residue single-chain peptide has four intra-chain disulphide bridges and, at $\text{pH } 4.7$, contains 245 exchangeable hydrogen atoms, 123 in side-chains and 122 in the backbone. About two hundred atoms (all those in the side-chains and about seventy-five in the backbone) undergo very rapid exchange. The rest require five hours at 40° for complete exchange, presumably due to the stabilizing of hydrogen-bonded structures by the disulphide bridges. In the case of insulin, the monomer has the two-chain (21 and 30 residues) structure with two inter-chain and one intra-chain disulphide bridges. There are 91 exchangeable hydrogen atoms, 43 in the side-chains and 48 in the backbone. 61 atoms (all those in the side-chains and 18 in the backbone) undergo very rapid exchange, 7 somewhat slower exchange, and 23 very slow exchange. It is suggested that the 23 very sluggish atoms are in the backbone sections between the inter-chain bridges.

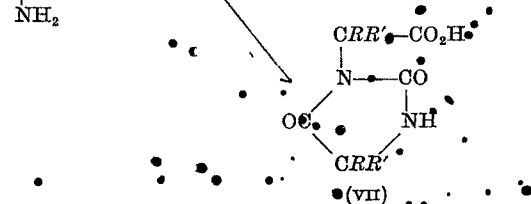
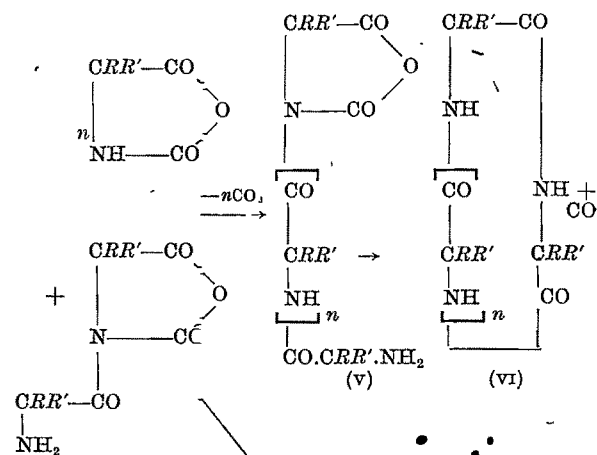
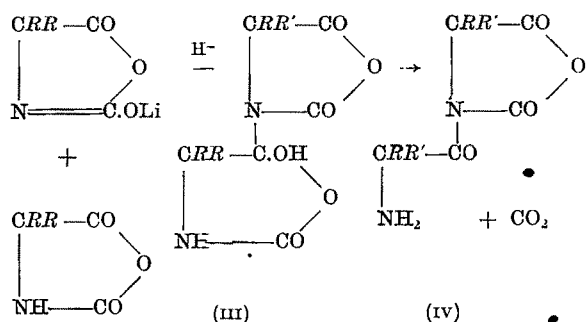
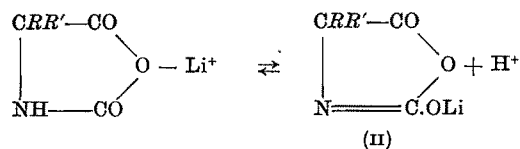
In the discussion of this paper, Dr. K. Schlogl (Vienna) asked if the exchange method could be used for studying a postulated enolization of peptide bonds in alkaline solution. Prof. Linderstrøm-Lang said that the exchange reaction, in some cases, is faster in alkaline solution, but he did not feel this to be due to enolization. Dr. D. Crowfoot Hodgkin (Oxford) pointed out that the 'loop' in insulin is stereochemically favourable for β -pleated sheet and α -helix peptide configurations and suggested the possibility of an exchange study of this. Dr. J. I. Harris (Copenhagen) directed attention to the fact that species variation of amino-acid composition of insulins is confined to the 'loop'. Dr. F. Sanger (Cambridge) confirmed this and asked if the difference between pig and sheep insulins (alanine for threonine and

glycine for serine) could be detected by exchange methods; Prof. Linderstrøm-Lang thought this might be possible.

The second paper, by Dr. C. H. Bamford (Courtauld, Maidenhead), dealt with recent work with Dr. D. G. H. Ballard on the mechanism of the N-carboxy- α -amino-acid anhydride synthesis of polypeptides. In the normal polymerization, the propagation reaction is of the type:



the product then reacting with more carboxyanhydride. Recently, however, reactions of other types have been observed: notably those of (I; $R^5 = H$) with sodium and lithium ions in polar solvents to give cyclic polymers (VI) together with some of the 3-hydantoinylacetic acid (VII). It is suggested that these reactions proceed as follows:

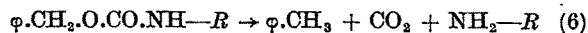
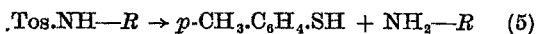
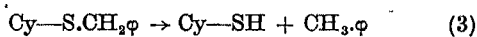
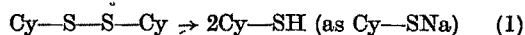


The grounds for these postulates are: (1) the nature of the products; (2) the essential nature of the NH group in the carboxy-anhydride; (3) the strong inhibiting effect of acids; and (4) the agreement between the kinetic data calculated from these equations and those actually observed.

The work described is a kinetic study (by rate of evolution of carbon dioxide) of the reactions of the anhydrides of N-carboxyl-DL-phenylalanine and γ -benzyl-N-carboxy-L-glutamate in nitrobenzene/N-methylformamide solution in the presence of sodium β -phenylpropionate. The kinetic studies and an analysis of the molecular weights of the reaction products support the view that "the essential feature of the salt-initiated polymerizations of the carboxy-anhydrides is the formation of a complex of type (II), which behaves as an activated form of the carboxy-anhydride. It initiates polymerization by reacting with the carboxy-anhydride to yield bifunctional intermediates, which couple and also enter into a growth reaction involving the complex. The initial rates of reaction are consequently very high, and the degrees of polymerization in general much greater than would be expected from the ratio [carboxy-anhydride]:[initiator]. In these respects the reactions differ fundamentally from the simple polymerizations catalysed by primary or secondary bases".

In the discussion on this paper, Dr. K. Schlögl criticized the suggested mechanism on several grounds, and Dr. Bamford gave a detailed reply to this criticism. Dr. J. A. Stock (London) asked if initiation by the sodium salts of amino-acids would yield cyclic polypeptides; Dr. Bamford felt that yields would be lower than with lithium chloride initiation.

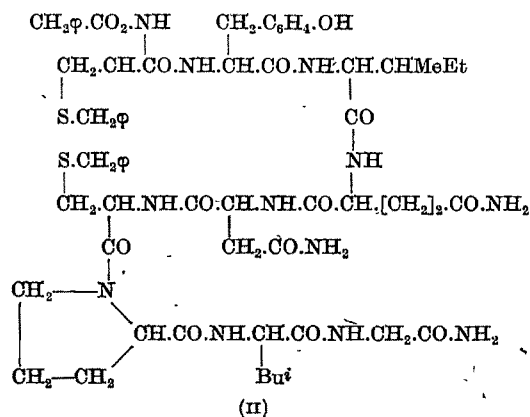
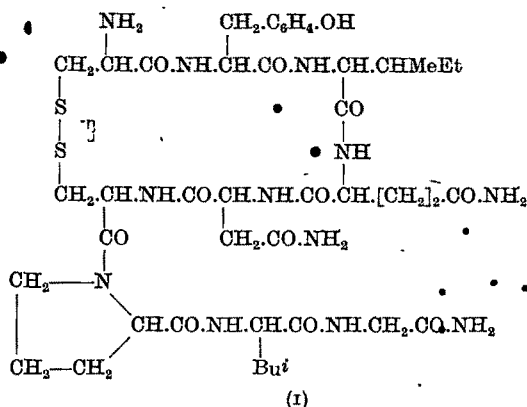
In the third paper, Prof. V. du Vigneaud (Cornell University Medical College, New York) described his studies on the synthesis of cystine peptides, dealing especially with the reactions in liquid ammonia. These studies, extending over the past twenty-five years, have recently culminated in the brilliant synthesis of the peptide pituitary hormone, oxytocin. The following reactions, critically important for peptide work, have been achieved in liquid ammonia solution in the presence of sodium:



Moreover, favourable conditions have been devised for the reversal of reaction (1) by aeration in aqueous solution.

All these reactions, except (4), were used in the oxytocin synthesis. The first major application of these techniques was in the 1936 synthesis of glutathione, which had been synthesized in 1935 by Harington and Mead without resource to the liquid ammonia reactions.

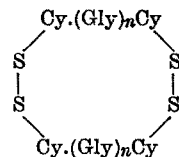
The isolation of highly purified oxytocin and subsequent degradative studies, 1949-53, indicated the cystine bridge-cyclized nonapeptide triamide structure (I).



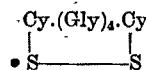
The compound (II) was successfully synthesized, the N- and S-protecting groups removed (Na/NH_3) and the disulphide bridge formed by air oxidation, yielding structure (I). The synthetic material was rigorously compared with natural oxytocin and found to be identical with it, in chemical, physical and physiological properties.

Sir Charles Harington opened the discussion on this paper with a tribute to Prof. du Vigneaud, and asked if a synthetic approach to insulin might be envisaged. Prof. du Vigneaud, remarking on the occurrence of the 20-membered loop in both insulin and oxytocin, said: "One has a right to dare to think that insulin could be synthesized, but it is of another order of magnitude of difficulty".

Prof. H. N. Rydon (Manchester) spoke briefly of his work on the air oxidation of the five peptides $\text{HS.Cy.(Gly)}_n\text{Cy.SH}$ ($n = 0, 1, 2, 3, 4$). With $n = 0$ and 1, the main products are antiparallel cyclic dimers



and with $n = 4$, the cyclic monomer

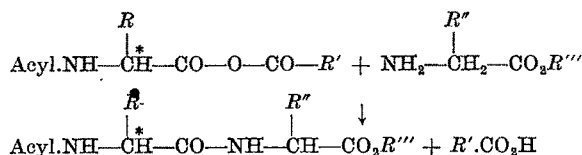


containing the 20-membered ring.

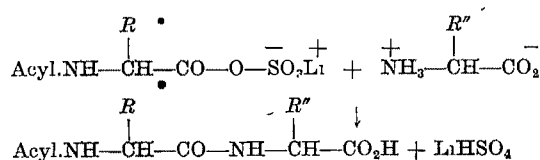
Dr. J. I. Harris (Carlsberg Laboratory, Copenhagen) read the fourth paper, describing his studies on C-terminal residue identification with carboxypeptidase. He outlined the experimental procedures and discussed the results obtained from insulin, somatotropin, α -corticotropin and tobacco mosaic virus. In general, cleavage is fastest with C-terminal aromatic amino-acids, very slow with an acidic or basic C-terminal residue and does not occur with C-terminal proline. Thus with the B-chain of insulin which has the terminal sequence . . . Pro.Lys.Ala., the alanine is released by carboxypeptidase, but reaction stops at that stage. With α -corticotropin, however, with the terminal sequence . . . Pro.Leu.Glu.Phe., the last three residues are split off in sequence. The summarized individual results per mole are: insulin gives one alanine and one asparagine, somatotropin, two phenylalanine; α -corticotropin, one phenylalanine, then one glutamic acid, then one leucine; tobacco mosaic virus, 2,900 + 100 threonine. The C-terminal sequences do not seem to be of critical importance for biological function. Dr. Harris, acknowledging the power of the enzymic methods, notably their very gentle experimental conditions, pointed out the need for a chemical method of study of C-terminal residues.

In the discussion, Prof. C. Fromageot (Paris) pointed out that ovomucoid is inert to carboxypeptidase but yields phenylalanine with lithium aluminium hydride. Dr. Harris felt that this must arise from some non-terminal fission. Dr. K. Schlogl advocated the Akabori hydrazine method for chemical study of C-terminal residues, to which Dr. Harris indicated the objections to a chemical method involving the complete degradation of the peptide chain.

Dr. G. W. Kenner (Cambridge) read the final paper, on mixed anhydride syntheses of peptides. He traced the development of the technique based on the reaction



from the work of Wieland, Vaughan and Boissonas ($R' = \phi$ originally, then = Bu^t, then = OEt). There is grave danger of racemization at C* and there are difficulties in the removal of R''' (though these have been largely overcome using $R''' = \text{CH}_2\phi$ and removing it by hydrogenolysis). To avoid these difficulties, Dr. Kenner has developed the use of mixed anhydrides of acylamino-acids and sulphuric acid, which will react, with very slight racemization, with free amino-acids and peptides in aqueous dimethylformamide solution



In the discussion, Dr. G. T. Young (Oxford), commenting on the importance of avoiding racemization, reported that, in the condensation of acetyl-L-leucine

with glycine, ethyl ester configuration is retained using the Curtius azide method but lost using the Goldschmidt phosphorazo method. Prof. J. Baddiley (Newcastle upon Tyne) asked if the sulphuric anhydride method could be used to link an amino-acid to an amide NH₂ group, and to this Dr. Kenner replied that he felt it to be unlikely.

H. D. SPRINGALL

CAMBRIDGE OBSERVATORIES

REPORT FOR 1954

THE report of the Observatories Syndicate of the University of Cambridge for the year ending September 30, 1954*, is divided under the following headings: reconstruction and re-equipment; solar research; stellar photometry; other investigations; optics; buildings and grounds; lectures; and papers accepted for publication. The installation of the new 17-24-in. Schmidt telescope has been completed and tested extensively, and the original driving error—approximately a sine wave of total 6"—has been removed. The old Common 36-in. reflector has been dismantled and returned to the Science Museum, South Kensington, and the foundations for the new 36-in. reflector are ready for the telescope, which was expected to be delivered in December.

A great portion of the report dealing with solar research is devoted to the observations of the total solar eclipse of June 30, 1954, details of which have been already given in various publications. Plans were made, and preparations commenced, for observation of the total eclipse of June 20, 1955, when Dr. D. E. Blackwell will continue the work which he carried out at the 1954 eclipse—photographing the corona and zodiacal light, etc., to make accurate photometric measurements; a Sunderland flying-boat will be used, flying from the Fiji Islands over the Pacific Ocean (*Nature*, June 11, p. 1018). Prof. R. O. Redman, the director of the Observatories, and Dr. Z. Suemoto have completed the study of chromospheric line-widths, based on spectrograms obtained at the 1952 eclipse. Self-absorption and Stark effects, which are of greater importance than had been formerly supposed, having been taken into account, they have shown that the line-widths in the hydrogen Balmer series are consistent with a kinetic temperature not exceeding 10,000° K. and also that a model at 6,000° K. would represent the measures almost as well as at 10,000° K. In addition to other solar work, reference may be made to the critical examination in the 30-ft. spectrograph of two large, good-quality gratings, both with 600 lines per mm., one from Bausch and Lomb, of ruled area 20 cm. × 15 cm., and the other from the Mount Wilson Observatory, with ruled area 20 cm. × 13.7 cm.; the latter is on loan to the Observatories and "gives quite remarkable performance, theoretical resolving power being attained in the fifth order". It is to be embodied in a Babcock magnetograph for recording weak magnetic fields and Doppler effects on the sun's surface.

Under the heading of stellar photometry, it is very satisfactory to know that the Royal Astronomical Society has decided to publish in its "Memoirs" the results of the +15° Selected Areas programme of

* University of Cambridge. Report of the Observatories, for the year ending September 30, 1954. Pp. 4. (Cambridge: University Press, 1955.)

stellar photometry, thus obviating the difficulties encountered in finding the necessary funds. Investigations on the performance of the 17-24-in. Schmidt telescope, in which Prof. H. A. Brick, director of the Dunsink Observatory, co-operated by allowing the Richer photometer to be used for measuring test plates, have shown that with a filter removing the ultra-violet below about 4000 Å. star images can be measured satisfactorily to mag. 18 photographic on a 30-min. exposure (Ilford 'Zenith' plate).

Under the heading of "Other Investigations", an account is included of the test and adjustment work on the Schmidt telescope. To acquire familiarity with the instrument, a programme of photography of discrete radio sources has been undertaken, using positions provided by the Cavendish Laboratory's radio-astronomy group, and about a hundred photographs have been obtained. Up to the present, the results have not been encouraging, and it seems possible that most of these sources cannot be profitably photographed with this telescope.

In the section on optics, reference may be made to the experimental work which has been continued on the production of mirrors relatively free from thermal distortion, which would be useful for solar work, and experiments are being made with thin glass bonded with plastic glue to a mild-steel support. The assistance of the firm of Aero Research, Ltd., is acknowledged in the preparation of these disks. An investigation into the problem of assessment of optical images has been made by Dr. E. H. Linfoot and Dr. P. B. Fellgett, and a paper on the subject will appear later (*Phil. Trans. Roy. Soc.*).

During the year, twenty-four lectures on the sun were given by Prof. Redman; sixteen on optical aberration and eight on diffraction theory of the optical image by Dr. E. H. Linfoot; twenty-four on general astrophysics by Dr. D. E. Blackwell; and fifteen on elementary electronic techniques and fifteen on spherical astronomy by Mr. G. G. Yates. The Observatory Club held twelve colloquia during the year, at which the speakers included Prof. W. M. H. Greaves, Dr. J. Houtgast, Mr. G. M. Sisson and Dr. P. A. Sweet. Fifteen papers were accepted for publication in various scientific journals during the year.

MALAYAN ANNONACEAE

J. SINCLAIR has contributed to our knowledge of an important family of tropical flowering plants in his "Revision of the Malayan Annonaceae" (*Gardens' Bull.*, 14, 2, 149; 1955; Govt. Printing Office, Singapore; 10 dollars).

The Annonaceae are confined mostly to moist tropical lowland forests, being more plentiful in the Old World than in the New. In the present revision, there are thirty-eight genera, comprising 198 native and five cultivated exotic species, making a total of 203, together with seventeen varieties.

Points of difference between the present and earlier classifications are indicated. The main taxonomic section begins with an account of the general characters of the family, including fairly comprehensive and detailed references to the main morphological characters; here special attention is paid to the petals, which are stated to be of greater diagnostic value in this family than any other organ. "They show such a wonderful diversity in size and form that

it may be said the peculiarities of the family are exhibited in its petals." They are, in fact, the main basis of classification in this group of flowering plants.

Because in the Annonaceae there are orderly progressions leading from one group to another, the constituent tribes are rather ill-defined, with overlapping characters. The author has summarized the inferences of evolutionary import as follows: "There are in the family very noticeable evolutionary trends which have a bearing on classification. Since evolution proceeds neither evenly nor at the same rate, we find genera advanced in some characters and primitive with regard to others. There is a tendency to proceed from simplicity to complexity, for example, from simple petals with no distinction between blade and claw to the complex dome-shaped petals of the Mitrephoreae with their long narrow claws and united blades; from the clumsy stamen with a great deal of connective tissue to a more precise form with a filament and greater development of the pollen sacs. There is a tendency for reduction from many seeds in two rows to a single better nourished seed and also a union of parts to give more protection. The petals become united and the stamens become fewer. The greatest advance of all is where the carpels unite to form a 1-celled ovary with parietal placentation and there is thus a division of the family into two sub-families, the Annonoideae (apocarpous forms mostly) and the Monodoroideae with a 1-celled ovary, parietal placentation and gamopetaly (*Isolona* and *Monodora*)".

GRAFTING EXPERIMENTS BETWEEN THE TOMATO VARIETIES, GOLDEN APPLE AND OXHEART

By A. J. BATEMAN*

Cytogenetics Laboratory, Christie Hospital and Holt Radium Institute, Manchester 20

IN a recent issue of *Nature*¹, reference was made to tomato-grafting experiments by Dr. L. Felföldy of Hungary, whose results have been published in English². A special feature of the work was that spectacular results had been obtained with the varieties Golden Apple and Oxheart, which are known in Britain. In repeating this experiment, a closer parallel than hitherto should have been possible between Michurinist and Western experimenters. In a letter to Dr. Felföldy, I expressed my desire to repeat his work, whereupon I received seed of his own stocks. It is this identity of experimental material which emboldens me to publish one more set of results in addition to what has already appeared³. The work was carried out while I was on the staff of the John Innes Horticultural Institution, Bayfordbury.

Golden Apple has medium-sized, round, bilocular, yellow-fleshed, yellow-skinned fruits on simple inflorescences. Oxheart has very large, inverted pear-shaped, multilocular, red-fleshed, white-skinned fruits on branched inflorescences.

Felföldy describes his technique as follows: "The upper parts [of the tomato plants] were interchanged".

* British Empire Cancer Campaign Research Fellow.

Only the simplest method of grafting was used: "the leaves were not removed either from parent, stock or scion". The age of the plants at grafting is not stated; but it is implied that stock and scion were of the same age. His results are presented in simplified form, with some interpretation, in Table 1.

Table 1.

Seed from scions of Oxheart/Golden Apple grafts			Seed from scions of Golden Apple/Oxheart grafts		
O	18		G, extra vigorous	32	
O, with non-pointed fruits	12	—	G, with some fruits 4-locular	2	—
	30			34	
Possible sexual F_1 G, but with red-fleshed fruits, sometimes multilocular. Foli- age intermediate	1		O, non-pointed with flesh sometimes orange and skin yellow	6	
	5			—	
Total	36		Total	40	

G = Golden Apple or type; O = Oxheart or type

In my repetition, the first grafts were made with month-old plants. A wedge-shaped piece of stem from the scion was inserted in a slot cut in the main stem of the stock. The larger leaves were removed from the scion, and, in shaping the wedge, the first inflorescence was cut away. A lateral was allowed to grow on the stock in place of the main shoot. It was reasoned that this would maintain the vitality of the stock, without which its ability to influence the scion might be impaired. Three weeks from grafting, the scions of some grafts were defoliated and kept thus for the remainder of their growth. This would be expected to increase the effect of stock on scion.

A second series of grafts was made, of very young seedlings (twelve days from sowing) on to mature plants (two months old), with the wedge of the scion actually below the cotyledons. These scions were kept defoliated from the very first. Naturally enough, they grew very little and produced few fruits with few seeds (none at all in the Oxheart scions). All grafts were grown continuously in a heated glass-house.

Thus, while some grafts were in all material respects the same as Felföldy's, the rest were modified in ways which should increase the physiological dependence of scion on stock and thus, according to Michurinist principles, increase the yield of graft hybrids.

In my own material, as in Felföldy's, apart from an increased vigour of the scions in grafts of Golden Apple on Oxheart, there was no indication of interaction between the grafts in the first season.

Table 2

	Age of plants at grafting.	Defoliation	Truss No	Seed from Golden Apple	Oxheart	
Control	—	—	—	200	(missing)	
Stock	Stock and scion one month old	None	(on lateral stem)	184	162	
Scion	"	"	1	79	199	
	"	"	2	125		
	"	"	1	204		
	"	Of scion, from 3 weeks after graftings	2(base)	97		125
	"	"	(tip)	26		
	"	"	"	52		
Stock 2 months, scion 12 days	Of scion, from grafting	2	10	23		
		3	13			
	Totals from scions			402	324	
	Totals from grafts			586	486	
	No of graft hybrids			nil	nil	

Seed was saved from both stock and scion, each fruit being kept separate and its truss recorded. Each test family was from a single fruit. Details of the origin of each family are given in Table 2.

Mature plants were produced from 586 seeds of Golden Apple grafted to Oxheart and from 486 seeds of Oxheart grafted to Golden Apple. Not one of these showed evidence of vegetative hybridization for unambiguous characters such as fruit colour, skin colour, fruit shape, and number of loculi. One plant from Golden Apple had small seedless fruits and narrow leaves. It showed no signs of Oxheart influence. Its aberrance was evidently due to some other cause, say, aneuploidy. Golden Apple fruits are extremely uniform and any Oxheart influence should have been readily recognized. In Oxheart progeny, on the other hand, the recognition of hybrids would not be so easy, as the fruits are always very variable in size and shape, though constant in skin and flesh colour of the ripe fruits. It was, however, always possible to find at least one typically shaped fruit on a plant.

There was one complication. One of twelve plants from the first sowing of Oxheart seed as supplied to me proved to be an F_1 hybrid the parents of which had evidently been the two varieties under study. If such a plant had been inadvertently used as scion in a graft-hybrid experiment, some of Felföldy's results could be explained. Though I found no cases of spontaneous cross-fertilization in my material, Hungarian conditions are evidently more conducive to it.

Felföldy claimed twenty-two out of forty seedlings from Oxheart on to Golden Apple as hybrids. Of these, however, twelve can be explained as typical environmentally produced variants, and one appears to be an F_1 hybrid, leaving five which cannot be explained so easily. Similarly, in the Golden Apple-Oxheart series there are six variants out of forty, which, if we do not accept as genuine vegetable hybrids, are difficult to account for. Nevertheless, this hard core of fifteen 'hybrids' out of eighty is in such contrast to 0 out of 1,072 in my own experiment, which on the face of it provided more favourable conditions for vegetative hybridization, that one cannot take it seriously. [Feb. 10]

Since the above account was written, Dr. Felföldy has kindly sent me the results of raising a further seed generation from the variants obtained in his grafting experiments.

Oxheart/Golden Apple grafts (see Table 1).

O : 40 plants raised, bred true as typical Oxheart.

O, with non-pointed fruits : 39 plants, bred true as a non-pointed form of Oxheart. My earlier conclusion that this would be non-heritable variation is thus wrong. Either the variant is a result of grafting or the original Oxheart was polymorphic, consisting of two true-breeding lines, one pointed, the other flat. This is not unusual in commercial strains of inbreeding crops.

Possible sexual F_1 : This did indeed produce a typical F_2 segregation (39 plants), which agreed closely with the progeny of the chance F_1 hybrid which appeared in my own experiment. There was Mendelian segregation for flesh and skin colour and a more indeterminate (probably polygenic) variation for fruit shape and loculus number.

The progeny of the last category (29 plants, of which 27 produced ripe fruits) segregated for flesh colour (21 red; 6 yellow) and skin colour (21 yellow

6 colourless) but bred true for the other fruit characters. It must have been a hybrid of some kind, but if a sexual one, it was not between Oxheart and Golden Apple.

Golden Apple/Oxheart grafts.

G. extra vigorous: 40 plants; and

G. with some fruits 4-locular: 28 plants. Both these classes produced only typical Golden Apple plants, vindicating my characterization of the latter group as non-heritable variants.

O. non-pointed: this was another class which I was unable to explain. It must have been a hybrid of some kind. Eight plants were raised, of which only five plants produced ripe fruits, but there was segregation for skin colour.

¹ McLaren, Anne, and Michie, D., *Nature*, 174, 390 (1954).

² Felföldy, L., *Acta Biol. Acad. Sci. Hung.*, 2, 3 (1951).

³ Sachs, L., *Nature*, 167, 282 (1951). Wilson, K. S., and Withner, C. L., *Amer. J. Bot.*, 33, 796 (1946).

⁴ Bateman, A. J., *Ann. App. Biol.*, 39, 129 (1952).

A SIMPLE AND RAPID ASSAY OF OXIDATIVE PHOSPHORYLATION

By DR. BRITTON CHANCE and DR. G. R. WILLIAMS

Johnson Research Foundation, University of Pennsylvania, Philadelphia

IN seeking a method for the assay of oxidative phosphorylation that could be used under the same conditions as the spectrophotometric methods¹, we have developed a simple and rapid assay method that may be of general interest. By taking advantage of the fact that carefully prepared mitochondrial preparations are 'tightly coupled'—that is, respire only slowly in the absence of phosphate acceptor²—we find it is possible to measure accurately the amount of rapid respiration caused by the addition of a known concentration of adenosine diphosphate.

Respiration is most conveniently measured with a modified form of a vibrating platinum microelectrode³, which has a more rapid response than the stationary electrode⁴ and is more convenient than the rotating electrode⁵. The particular form of electrode developed for these purposes is suitable for insertion into a cuvette for the simultaneous measurement of spectroscopic, respiratory and phosphorylative effects¹. An 8-ml. glass-coated open type of electrode is attached to the reed of a Brown Instrument Company's converter that vibrates the electrode at 60 c./s. and also forms a part of the electronic amplifying circuit (Chance, unpublished work). The electrode is polarized at -0.6 V.

Accuracy and controls. The linearity of the electrode has been tested by inserting it into solution equilibrated with various oxygen concentrations obtained from a gas mixer⁶, or by measuring its response to the zero-order respiration of a suspension of yeast cells. The non-linearity is less than 10 per cent. The calibration with a known oxygen concentration is explained in conjunction with Fig. 1.

Since the experiments with mitochondria are most conveniently carried out in an open cuvette in order to permit addition of reagents, there can be mixing of the air-saturated interfacial layer with the contents of the cuvette. This mixing-rate is negligible compared with the respiration-rate of the suspensions when adenosine diphosphate is present; but in its absence, rates of respiration less than 0.1 μM

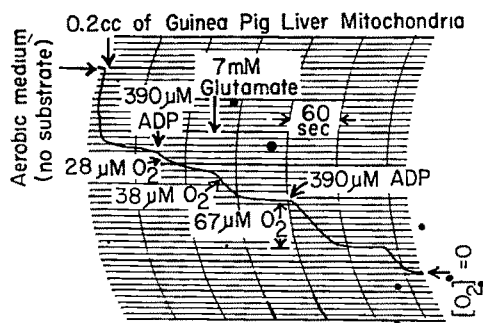


Fig. 1. Effect of additions of adenosine diphosphate upon the respiration-rate of guinea pig liver mitochondria as recorded by the vibrating platinum microelectrode. The mitochondria are diluted in a medium containing all factors except substrate and phosphate. The addition of the various reagents is indicated on the graph (Exp. 372)

oxygen/sec. may be in error at half atmospheric concentrations of oxygen.

The solubility of air in the reaction medium is computed according to ref. 7. The concentration of adenosine diphosphate is assayed spectrophotometrically⁸, and the samples used (Sigma chromatographed) contained more than 95 per cent adenosine diphosphate, the remainder being largely adenosine monophosphate.

The mitochondria were prepared according to a modification of the method of Schneider⁹ similar to that used by Lardy and Wellman². Glass-distilled water was used throughout. The reaction medium contains 0.038 M Na⁺, 0.087 M K⁺, 0.006 M Mg⁺⁺, 0.096 M Cl⁻, 0.013 M HPO₄⁼⁼, 0.003 M H₂PO₄⁻, 0.012 M F⁻.

Fig. 1 illustrates the important aspects of this method. The brief portion of the trace that begins in the upper left portion of the figure is obtained by inserting the electrode into air-saturated reaction medium. When the mitochondrial suspension (0.2 c.c.) is added to the reaction medium, the electrode current shows an abrupt decrease (downward deflexion) caused by the dilution of the oxygen in the reaction medium by the anaerobic mitochondria and by a diminished sensitivity of the electrode in the presence of the mitochondrial proteins⁴. The remaining oxygen concentration is readily computed from the dilution factor (0.8 for Fig. 1), and this value serves to calibrate the electrode sensitivity, the zero point being given by anaerobiosis.

The mitochondrial respiration is rather slow because the endogenous adenosine diphosphate-level is very low, but is considerably increased by the addition of adenosine diphosphate as illustrated by the increased slope of the trace. This increased respiration is brief, and in less than a minute the respiration has very nearly ceased. In this case the adenosine diphosphate is still present; but the endogenous substrate has been exhausted. Now addition of 7 mM glutamate causes a very rapid respiration which halts abruptly when the original addition of adenosine diphosphate becomes exhausted. Since ample substrate is now present, a second addition of adenosine diphosphate initiates respiration that continues until the adenosine diphosphate is used up. A third addition of adenosine diphosphate restarts the rapid respiration that is stopped this time by exhaustion of the dissolved oxygen in the reaction mixture and the system becomes anaerobic.

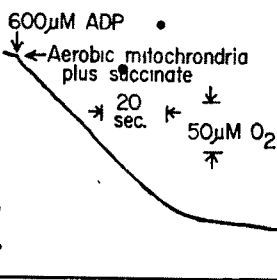


Fig. 2. Kinetics of initiation and cessation of rapid respiration. Rat liver mitochondria with succinate as the substrate (Exp. 332b)

Different portions of this record illustrate various aspects of the method. Taking up the additions of adenosine diphosphate in reverse order, the third one illustrates the calibration of the electrode sensitivity between the limits of zero oxygen and that of the reaction mixture diluted by the mitochondria. The second addition of adenosine diphosphate causes a rapid oxygen uptake of $67 \mu\text{M}$ for the utilization of $390 \mu\text{M}$ adenosine diphosphate. The ratio of adenosine diphosphate to atoms of oxygen is 2.9. A control on the destruction of adenosine diphosphate in the absence of respiration is provided by the first addition of the diphosphate. In this case the total time for the utilization of adenosine diphosphate is 70 sec. as compared with 40 sec. in the case of the second addition. Yet the oxygen utilized is very nearly the same, 66 and $67 \mu\text{M}$ respectively. Thus just as much oxygen must be utilized to exhaust the adenosine diphosphate in the longer period as in the shorter period, and the rate of utilization of adenosine diphosphate in processes that do not lead to respiration is negligible.

The first addition of adenosine diphosphate also illustrates that the mitochondria contain a definite amount of readily available endogenous substrate, in this case equivalent to $28 \mu\text{M}$ oxygen. The nature of the endogenous substrate is not known; but malonate is a potent inhibitor of this respiration. With rat liver mitochondria, the value of the ratio of adenosine diphosphate to atoms of oxygen for the endogenous substrate is less than that for β -hydroxybutyrate, and consequently its initial values are less than the final values obtained after the endogenous substrate has been oxidized.

The initiation and cessation of respiration upon addition of adenosine diphosphate is recorded on a faster time scale as shown by Fig. 2, in which succinate is used as the substrate for a rat-liver preparation. Rapid respiration is initiated in the mixing time (~ 1 sec.), much more rapidly than can be shown by the manometric method¹⁰.

The cessation of rapid respiration is also abrupt, and by plotting the rate of respiration as a function of the change of oxygen concentration, we find that the respiration falls to half the rapid value with an oxygen utilization of only $7.5 \mu\text{M}$. For a value of 2.0 for the ratio adenosine diphosphate to atoms of oxygen for succinate, we find that the 'Michaelis constant' for the deceleration of respiration by exhaustion of adenosine diphosphate is $7.5 \times 2 \times 2 = 30 \mu\text{M}$ diphosphate. If this experiment is repeated by adding small amounts of adenosine diphosphate and measuring the respiration rate, a value of $20 \mu\text{M}$

diphosphate is obtained for a guinea pig liver preparation. These values are probably more representative than those of Slater and Holton¹⁰, where a high endogenous concentration of adenosine diphosphate was present in the 'loosely coupled' heart sarcosomes.

The rapidity with which respiration is initiated and the high affinity for adenosine diphosphate are sufficient to account for the available experimental data on intact muscle, for example, Millikan's finding that 10–25 per cent of the oxyhemoglobin reservoir of cat's soleus muscle was expended 1 sec. after a tetanic contraction¹¹. It is also apparent that the affinity of the oxidative phosphorylation system for adenosine diphosphate is sufficient to respond to a fraction of the concentration of the diphosphate that is believed to be released by a single muscle twitch. The 'Michaelis affinity' for adenosine diphosphate is about $25 \mu\text{M}$, whereas the amount thought to be released per twitch is equivalent to 300–500 μM ¹²; thus only about 6 per cent of the adenosine diphosphate released per twitch should be needed for half-maximal stimulation of respiration. This conclusion is supported by our experimental observations of a change in the steady-state level of intracellular pyridine nucleotide following a single twitch of aerobic frog sartorius muscle at 0°C .¹³

Since we have shown that a negligible amount of adenosine diphosphate is utilized by these preparations without causing respiration, and that the affinity of the system for the diphosphate is very high, we may conclude that there is an incorporation of inorganic phosphate equal to the amount of added adenosine diphosphate in the interval of rapid respiration (see Figs. 1 and 2). A relatively crude analysis of inorganic phosphate uptake¹⁴ at the end of this interval gave 1.6 and 1.5 mM phosphate disappearance compared with 1.7 mM adenosine diphosphate added. Thus it is reasonable to regard our adenosine diphosphate/oxygen ratios as phosphorus/oxygen ratios without correction. While we do not claim to settle finally the controversial question of phosphorus/oxygen values by these results¹⁵, we do believe that the simplicity, rapidity and directness of this method have much to recommend it. For a typical guinea pig liver preparation we find the phosphorus/oxygen (atoms) values to be 3.1 with glutamate as a substrate. An average value of 3.1 is obtained from four determinations with rat liver mitochondria using β -hydroxybutyrate as a substrate. Ten determinations of the relative phosphorus/oxygen values for succinate and β -hydroxybutyrate gave the factor 0.68 as a result. Full details of this work will be published elsewhere.

The support of the National Science Foundation and the Office of Naval Research is gratefully acknowledged.

¹ Chance, B., *Science*, **20**, 767 (1954).

² Lardy, H. A., and Wellman, H., *J. Biol. Chem.*, **195**, 215 (1952).

³ Harris, E. D., and Lindsay, A. J., *Nature*, **162**, 413 (1948).

⁴ Davies, P. W., and Frink, jun., F., *Rev. Sci. Instr.*, **13**, 524 (1942).

⁵ Kolthoff, I. M., and Laitinen, H. A., *Science*, **92**, 152 (1940).

⁶ Hartree, E. F., and Harpley, C. H., *Biochem. J.*, **44**, 637 (1949).

⁷ "International Critical Tables", **3**, 271 (McGraw-Hill, New York, 1928).

⁸ Meyerhof, O., and Kaplan, A., *Arch. Biochem.*, **33**, 282 (1951).

⁹ Schneider, W. C., *J. Biol. Chem.*, **176**, 259 (1948).

¹⁰ Slater, E. C., and Holton, F. A., *Biochem. J.*, **55**, 530 (1953).

¹¹ Millikan, G. A., *Proc. Roy. Soc. B*, **123**, 218 (1937).

¹² Mommaerts, W. F. H. M., *Nature*, **174**, 1083 (1954).

¹³ Connelly, C. M., and Chance, B., *Fed. Proc.*, **13**, 94 (1954).

¹⁴ Lgwyry, O. H., and Lopez, J. A., *J. Biol. Chem.*, **162**, 421 (1946).

¹⁵ Slater, E. C., and Holton, F. A., *Biochem. J.*, **56**, 23 (1954). Lardy, H. A., and Copenlaver, jun., J. H., *Nature*, **174**, 231 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Interpretation of the Mechanics of Pulvinar Movement

KNOWLEDGE of the mechanics of pulvinar movement is based mainly on the work of Dutrochet¹, Pfeffer² and others conducted in the nineteenth century. They showed that if the upper half of the primary pulvinus was removed from the leaf of *Mimosa pudica* then leaf movement continued, although on a reduced scale. It was deduced from this that the lower half of the pulvinus is principally concerned with the movement, which was then accounted for in terms of loss of turgor followed by recovery. This early explanation of pulvinar mechanics is still widely accepted by workers in this field³, and has recently been used in drawing comparisons between the movement of guard cells and pulvini⁴. The results are briefly reported here of studies on leaf movement exhibited by *Samanea saman* Merrill and *Mimosa pudica*. In our view they cast doubt upon the validity of this explanation.

The above experiment was repeated, in a modified form, upon the secondary pulvinus of the leaf of *Samanea*, which has the same nyctinastic response as the primary pulvinus of *Mimosa*, that is, curving downwards in the evening towards the 'closed' position, and upwards in the early morning towards the 'open' position. During the day, this pulvinus supports the weight of the leaflets, to which it is attached by the rachis. The latter acts as a lever, so that a pressure is exerted upon the lower half of the pulvinus and a pull on the upper half. In the experiment described here the pulvinus was relieved of these forces. This was done by orientating the leaf in such a way that the pinna moved in the horizontal plane, instead of the vertical, and then by suspending the end of the pinna from a freely swinging arm with a fine thread.

Three leaves were set up as above. The first served as a control, and it showed the normal nyctinastic movement, although now in the horizontal plane. At midday the upper half of the pulvinus was removed from the second leaf, and the lower half from the third. Afterwards the second pulvinus curved a little farther in the 'open' direction, where it remained permanently, the nyctinastic movement disappearing completely. The pulvinus of the third leaf commenced to 'close' immediately after the removal of the lower half. When it had attained the fully 'closed' position, no further nyctinastic movement was shown by it also. In each case the remaining half of the pulvinus stayed fully turgid and healthy in appearance throughout the experiment. Identical results were obtained when this experiment was repeated using the primary pulvinus of *Mimosa*. Here the seismic response also disappeared. This confirmed the work of Bert⁵, who reported that movement in *Mimosa* disappeared when the petiole was placed on its side and the upper half of the pulvinus removed. Thus neither the upper nor the lower half of the pulvinus alone is able to bring about leaf movement. This suggests that movement in the complete pulvinus is due to the upper and lower halves alternately expanding and compressing the opposite half.

It was confirmed that a reduced movement occurs in the normally orientated leaves of *Mimosa* and

Samanea when the upper half of the primary pulvinus of *Mimosa*, or the secondary pulvinus of *Samanea*, is removed. It can now be attributed to the leverage effect already described, which acts upon the lower half of the pulvinus as a compressing force, inducing the cells to lose water, with subsequent contraction in volume. Hence a nyctinastic or seismic movement can take place under these conditions. Confirmation of this explanation comes from experiments on *Samanea*, in which a small, constant, upwardly directed force was applied continuously to a pulvinus from which the lower half had been removed. Reduced nyctinastic movement then occurred, although such movement is not normally shown by the upper half alone. The occurrence of a nyctinastic rhythm in circumstances where one remaining half of the pulvinus is subject to a constant compressing force suggests that the ability of the cells to withstand compression varies diurnally. In the complete pulvinus it is least among cells of the lower half at the end of the day. Therefore at this time the force exerted by the upper half, together with the leverage effect, is now sufficient to cause the cells of the lower half to lose water. The tissue is then compressed into a smaller volume and, as a result, the pulvinus curves downwards and the leaf 'closes'. In the early morning the reverse occurs, the cells of the lower half regaining their turgor and exerting a compressing force on the cells of the upper half, which in their turn are now least able to withstand compression. They lose water and are compressed so that the pulvinus bends the leaf back into the 'open' or day position.

It is therefore concluded that pulvinar movement is caused by a force resulting from increase in turgor in one half of the pulvinus acting on cells in the other half, which are in a receptive state for compression. In the case of 'closure', this force may be supplemented by the effect of gravity.

G. F. ASPREY

J. H. PALMER

Department of Botany,
University College of the West Indies,
Mona, Jamaica, B.W.I.
Feb. 28.

¹ Dutrochet, M. H., "Mémoires pour servir à l'histoire anatomique et physiologique des végétaux et des animaux" (Bruxelles, 1837).

² Pfeffer, W., "Physiologische Untersuchungen: *Mimosa pudica*" (Leipzig, 1873).

³ Weintraub, M., *New Phytol.*, 50, 357 (1951).

⁴ Williams, W. T., *J. Exp. Bot.*, 5, 343 (1954).

⁵ Bert, P., *Mem. Soc. Sci. Phys. Nat. Bordeaux*, 4, 11 (1867).

Rhythmic Flight Activity of Certain East African Trichoptera

WHILE studying the cyclical emergence of aquatic insects from Lake Victoria, observations were made on their flight activity throughout the night. Similar investigations¹⁻⁴ conducted in temperate regions have been chiefly concerned with terrestrial insects.

In the present study, the number of insects caught in a Robinson-type insect trap⁵ fitted with a 125-W. mercury vapour bulb was taken as a measure of flight activity. A receptacle containing alcohol placed inside the mouth of the trap ensured that all incoming insects were killed immediately. This container was changed at 10-min. intervals during 18.00-07.00 hr. East African Standard Time. The trap was situated about 300 metres from the lake-shore on raised ground. Plecoptera, Ephemeroptera, Hemiptera, Trichoptera, Coleoptera and Chironomidae were represented in the

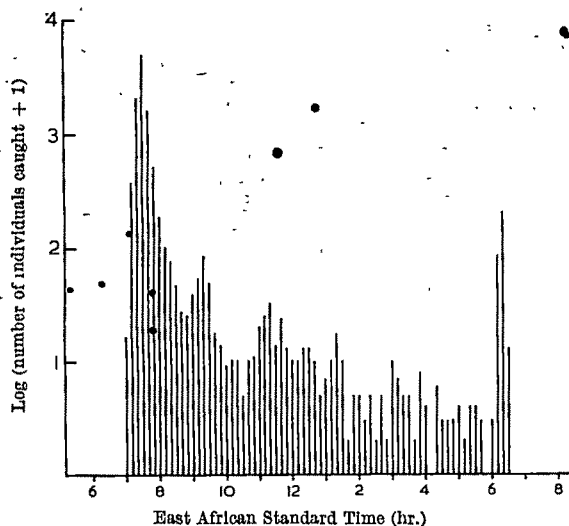


Fig. 1. Flight activity of *Cheumatopsyche* sp. nov. (Kimmins, in the press) (Hydropsychidae) throughout the night of January 5-6, 1955

catch; only certain species of Trichoptera were identified, sexed and counted. This involved inspection of more than 40,000 individuals collected on five nights in December 1954 and January 1955.

In the Ephemeroptera, Trichoptera and Chironomidae (considered as groups) flight activity was bimodal, the greatest numbers being caught shortly after sunset and again just before sunrise. A similar rhythm has been noted previously among Chironomidae in temperate regions⁴. In these instances it is not known to what extent this pattern of activity is brought about by the same species flying twice during the night or by different species, some flying only at dusk and others only at dawn.

Among the Trichoptera identified, we found that seven species showed a clear bimodal flight activity (Fig. 1). In six of these species the main flight occurred at dusk, after which the numbers declined gradually throughout the rest of the night. The dawn flight began and finished abruptly, and during this time activity in a single 10-min. period could sometimes exceed that observed at dusk the same night. In the seventh species the main flight occurred at dawn.

The significance of the two periods of activity in the life-histories of these insects is not clear. It seems likely that greater sexual activity occurs at dusk: copulation and oviposition have been observed more frequently at this time, and a smaller proportion of females occurs at dawn. The degree of synchronization observed may perhaps be an indication of a short reproductive life. In this connexion it may be remarked that animals in which activity is stimulated by crepuscular light intensities may be expected to show closer synchronization in tropical than in temperate regions.

The immediate practical outcome of these findings is that studies on the distribution, abundance and cyclical emergence of Trichoptera can now be made with far greater economy of effort since, by sampling during the dusk and dawn flights only, a collection can be obtained which not only includes a majority of the species flying during the night, but also a representative sample of the more abundant ones. This will substantially reduce the labour of sorting and identifying the material—a procedure which at present forms the principal barrier to progress in studies of this type.

This work was carried out at the East African Fisheries Research Organization, Jinja, and a full account is shortly to be published elsewhere.

PHILIP S. CORBET

East African Fisheries Research Organization,
Jinja, Uganda.

AUDFINN TJØNNELAND

Zoological Laboratory,
University of Bergen,
Norway.
Feb. 10.

¹ Larsen, E. B., *Ent. Medd.*, Copenhagen, 25, 263 (1948).

² Larsen, E. B., *Ann. Ent. Fenn.*, Helsinki (Supp.), 14, 154 (1949).

³ Stage, H. H., and Chamberlin, J. C., *Mosquito News*, 5, 8 (1945).

⁴ Williams, C. B., *Trans. Roy. Ent. Soc., Lond.*, 83, 523 (1935).

⁵ Robinson, H. S., and Robinson, P. J. M., *Ent. Gaz.*, 1, 3 (1950).

Shell-structure of the Brachiopod *Lacazella mediterraneum* (Risso)

THE continued use of Beecher's ordinal classification¹ of the Brachiopoda despite its inconsistencies² is mainly due to his fascinating interpretation of Kovalevskii's observations³ on the development of the recent thecideid *Lacazella*. Beecher concluded that the pseudodeltidium was secreted not by the mantle fold of the thoracic segment but by the caudal segment, and that only later was it ankylosed to the pedicle valve. Further, the pseudodeltidium appeared to be identical with a similar structure invariably found in the extinct strophomenoids (the central group of his order *Protremata*), a comparison that led him to regard the thecideids as derivatives of that stock. In other articulate brachiopods (the *Telotrema* of Beecher), the delthyrium is usually constricted by deltoidal plates, sometimes fused into a single unit, which are undoubtedly secreted by extensions of the mantle. Thus on the assumption that the pseudodeltidium was a 'third shell', Beecher was able to draw a fundamental distinction between the two groups. Substance was added to the supposed alien nature of the pseudodeltidium by his belief that, in protrematous brachiopods the pseudodeltidium was always impunctate, even when the valves were punctate as in the strophomenoids.

The links in this chain of reasoning began to break when Kozłowski⁴ pointed out that the strophomenoids are not punctate in the terebratuloid manner. What had previously passed for punctae were in fact calcite spicules embedded in the inner fibrous layer and projecting from it as a series of tubercles. These cannot be homologized with the caecal extensions of the mantle which form the punctae and penetrate the outer lamellar layer of the shell as well as the inner fibrous one. The structure of the strophomenoid pseudodeltidium, therefore, does not differ from the rest of the shell; it appears impunctate because it is covered by the lamellar layer, which is never penetrated by spicules. A further modification of Beecher's views became necessary when Elliott⁵ showed that the valves of the thecideids are truly punctate. But the internal shell surface is also tuberculate in a manner reminiscent of the strophomenoids, and accepting the possibility that punctation had arisen independently in the thecideids, *Lacazella* and its Mesozoic ancestors could still have been derived from the strophomenoids.

Dried specimens of *Lacazella* (BM.ZB141) show that the entire shell, including the pseudodeltidium, is punctate in the terebratuloid manner even to the

possession, by the caecae, of setiferous brushes penetrating the outermost lamellar layer. From the disposition of the periostracum and the dried mantle relative to the hinge line, it also appears that the pseudodeltidium is deposited by an extension of the ventral mantle, the outer lobe of which fuses with the outer lobe of the dorsal mantle to produce a single thickened periostracal sheet lying across the hinge line as in terebratuloids. There is therefore no reason for supposing that the pseudodeltidium of adult *Lacazella* at least originates differently from the rest of the shell.

Moreover, the resemblance between the tubercles of *Lacazella* and the spicular surface of the strophomenoids is only superficial. In strophomenoids, as in most brachiopods, the calcite fibres of the inner shell layer are disposed obliquely to the lamellar layer, changing direction only in narrow zones peripheral to the embedded spicules. In *Lacazella* the fibres are inclined at high angles to the lamellar layer, and are segregated into closely spaced bundles in such a way that the fibres of each bundle splay out slightly, to lie more or less normal to the irregularly tuberculate inner surface of the shell. Consequently, the bundles in cross-section appear to be made up of a core of vertically disposed fibres surrounded by a zone of radiating ones. It is these bundles which have previously passed as pseudopunctae; but they do not possess a non-fibrous core of any kind, and are unrelated to the strophomenoid spicules.

Unusual as this shell-structure is, it is not unique. The tubercles of the terebratuloid *Megerlina lamarkiana* (Davidson) appear to be identical in origin with those of *Lacazella*; although since the tubercles of *Megerlina* are widely spaced, the fibres between them revert to the more usual oblique angle of disposition. Indeed, allowing for their wide scatter and taking into account punctation, the similarity between the shell-structure of the two stocks is striking.

The above observations emphasize the urgent need of a re-investigation of the development of *Lacazella*. Meanwhile, serious consideration must be given to the possibility that the thecideids were derived neotenusously, not from the strophomenoids, but from the schizophoroid young of some Triassic terebratuloid or punctate spiriferoid.

ALWYN WILLIAMS

Geology Department,
The Queen's University,
Belfast.
Feb. 28.

¹ Beecher, C. E., *Amer. J. Sci.*, Ser. 3, 44 (1892).

² Cooper, G. A., "Index Fossils of North America" (Wiley, 1944).
Arber, M. A., *Geol. Mag.*, 77 (1940).

³ Kovalevskii, A. O., *Izvest. Imp. Obshch. Lyub. Estest. Antrop. Étno.*, 14 (1874).

⁴ Kozłowski, R., *Palaeont. Polonica*, 1 (1929).

⁵ Elliott, G. F., *Ann. Mag. Nat. Hist.*, Ser. 12, 6, 693 (1953).

Shell-structure of Thecidean Brachiopods

In thecidean brachiopods, which range from the Rhaetic to the present day, the shell-structure is less definite, and shows more variation, than in many other brachiopod sub-orders. Investigations I have carried out of this point¹, as part of work undertaken for a "Treatise on Invertebrate Paleontology", resulted in the conclusion that the structure was initially obscurely pseudopunctate, becoming densely punctate when a certain degree of structural organization was attained. This punctation never shows the

regular *en quinconce* pattern of the terebratuloids; it was attained in different stocks at different dates.

These results were obtained from a study of thin sections prepared from specimens of the type-species of various thecidean genera. Since the major types of brachiopod shell-structure, impunctate, pseudopunctate and punctate, characterize large divisions of the phylum, further investigation was undertaken of available material and sections prepared of twenty seven thecidean species ranging in age from Lower Jurassic to Recent.

The results show that eighteen of these species are clearly punctate, and a further six are identified as "fibrous; ? scattered punctae". Two are fibrous without punctae; only one is clearly pseudopunctate and this genus (*Davidsonella*, Lower Jurassic) differs from all other thecideans in the extreme elongation of the brachial cavities. Clear punctation appears in certain species as early as the Lower Jurassic, and without association with brachial complexity as previously stated. This early punctation was noted by Deslongchamps² and inadvertently overlooked by me.

In view of the very small size of these brachiopods and the varied preservation of the material examined the evidence summarized above is now interpreted as indicating that the thecidean brachiopods are punctate.

This punctation is very irregular in development throughout members of the sub-order, and does not show the regular patterning of terebratuloid punctation. Investigation of the physiological significance of punctae in living brachiopods might throw light on this condition.

Davidsonella, exceptional in shell-structure and brachial form, may be of separate evolutionary origin, although conveniently grouped at present with the others.

G. F. ELLIOTT

Geological Research Centre,
Iraq Petroleum Co., Ltd.,
214 Oxford Street,
London, W.1.

¹ Elliott, G. F., *Ann. Mag. Nat. Hist.*, Ser. 12, 6, 693 (1953).

² Eudes-Deslongchamps, E., *Mém. Soc. Linn. Normandie*, 9, 230 (1853).

Feeding of Barnacles

At the start of an investigation into the rate of feeding of the different species of intertidal barnacles, I was surprised to find that there was very little published information on the methods employed for the capture of food or on the organisms eaten by these ubiquitous animals. Darwin¹ noted the presence of Infusoria and Confervae in the gut as well as the remains of quite large Crustacea, and the newly settled spat have been reared on pure cultures of unicellular Algae²; but Gruvel³ and Batham⁴ have described only a macrophagous method of feeding, whereby animals that touch the extended third to sixth cirri are immediately drawn into the shell by the cirri and masticated by the mouth-parts. It is therefore interesting to report that some experiments in progress show that the adult barnacle can feed on a very wide range of organisms, from a size of 1 mm. down to 2μ.

For example, a specimen of *Balanus perforatus* captured and ingested the following organisms, as demonstrated both by their removal from the water around the barnacle and their appearance in the faecal pellets:

Organism	Rate of feeding, as ml. water filtered per hr.	Time to 50 per cent clearance
Nauplii of <i>Artemia salina</i> , 0.75-1.0 mm. length	4-15	1½ hr.
<i>Peridinium</i> sp., 30µ diam.	2-9	1½ hr.
<i>Gymnodinium</i> sp., 10µ diam.	2-3	5 hr.
Rod-shaped bacteria, 2µ length	by examination of faecal pellets only	

As the minimum width of the spaces in the 'net' formed by the third to sixth cirri and the setae on them was at the least 33µ in this specimen, it is obvious that the cirri themselves could not have captured the Algae or Bacteria. Direct observation showed that the rhythmic beating of the cirri causes a current of water to pass over the mouth parts and the first and second cirri, which generally remain within the mantle cavity. These appendages, and especially the first and second cirri, bear groups of fine setae, of the order of 1µ wide and spaced only about 1µ apart; this is presumably the filter that captures the small organisms.

It is hoped to give details of the filtration mechanism in a later publication; meanwhile it can be suggested that the wide range of food capable of being eaten by barnacles in part explains their great success on the shore and their ability to live in such dense communities.

I am indebted to Dr. M. Parke and Dr. J. A. C. Nicol for help and advice in this investigation.

A. J. SOUTHWARD

The Laboratory,
Citadel Hill,
Plymouth.
March 4.

¹ Darwin, C., "A Monograph on the Sub-class Cirrhopedia. The Balanidae; the Verrucidae", 684 (London, 1854).

² Costlow, J. D., and Bookhout, C. G., *Biol. Bull.*, 105, 420 (1953).

³ Gruvel, A., "Monographie des Cirrhipèdes ou Thécostracés", 472 (Paris, 1905).

⁴ Batham, E. J., *Proc. Roy. Soc. New Zeal.*, 74, 359 (1945).

Chromosome Numbers in the Rutaceae

ORIGINAL chromosome counts for three members of the subfamily Rutoideae of the family Rutaceae are given as follows. *Correa backhousiana* has $n = 16$, in agreement with the counts for three other species of *Correa* found by Smith-White¹. *Evodia danielli* has $n = 40$, this count differing from that found by Bowden², who gives $n = 36$ for material grown on the Blandy Experimental Farm, University of Virginia. My material, originally obtained from North China, is now growing in the Royal Botanic

Gardens, Kew. Its chromosome number suggests aneuploidy. It is interesting to note the apparent existence of chromosome races within the species *Evodia danielli*. *Choisya ternata* has $n = 27$ —a first count for the genus.

Choisya ternata shows slightly irregular meiosis, the irregularities being manifested by a few lagging chromosomes at anaphase. When collected even at the most favourable growing period, the anthers exhibited a considerable percentage of shrivelled, empty or otherwise defective pollen. This may be indicative of a hybrid nature in this species.

Illustrations of the meiotic stages from which counts were obtained accompany this communication.

S. R. DESAI

Queen Mary College,
Mile End Road,
London, E.1.

¹ Smith-White, *Aust. J. Bot.*, 3, 287 (1954).

² Bowden, W. M., *Amer. J. Bot.*, 32, 81 (1945).

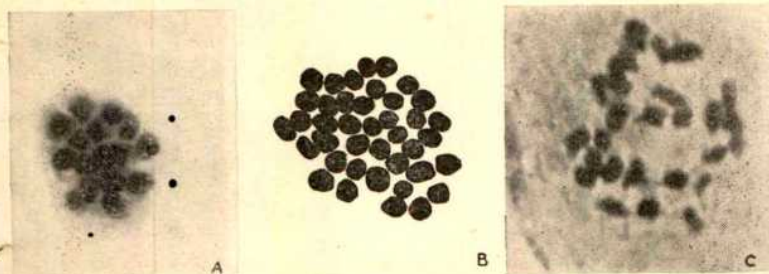
Properties, Function and Origin of the Alveolar Lining Layer

IN acute lung oedema in the rabbit, fluid and foam are found in the trachea. This foam has an altogether peculiar property, in that it is unaffected by silicone anti-foams; these rapidly destroy the foams produced by shaking oedema fluid or blood serum with air. Equally stable foam is found in the bronchi of an animal the respiratory movements of which have been paralysed and into the trachea of which a mixture of oxygen and ammonia gas has been insufflated for one or two hours; similar foams are obtained from healthy lung by cutting and squeezing under water, or after introduction of saline into the trachea. The stability of such foams is due to an insoluble surface layer on the bubbles; this layer can be attacked by pancreatin or by trypsin.

Oedema foam is thus not produced by agitation of the oedema fluid with air during respiration; it can only have been formed by air originally contained in the fine air spaces of the lung being broken up into bubbles and afterwards expelled into the bronchi and trachea. The lining layer of the bubbles cannot have come from the oedema fluid, and must therefore have formed the original lining layer of the fine air spaces. By drying and weighing samples of the foam of known bubble-size distribution, the thickness of the layer (assuming density 1.3) has been found to be about 50 Å.

In air-saturated water, bubbles (say 40µ in diameter) from foam from the lung usually remain unchanged in size for long periods (60 min.), whereas similar bubbles from serum and other foams, owing to their internal excess pressure, dissolve and disappear within a few minutes. The surface tension of the lung bubbles is therefore zero; or, to put this another way, the surface pressure of the layer is equal to the surface tension of the underlying liquid.

Published calculations on the pressure balance between the lung capillaries and the alveoli have disregarded the surface tension at the sharply curved, and probably moist, alveolar wall. If the surface tension were that of an ordinary liquid,



A, *Correa backhousiana*, first meiotic metaphase, pollen mother cell, $n = 16$ ($\times$ c. 1,270).
B, *Evodia danielli*, first meiotic metaphase, pollen mother cell, $n = 40$ ($\times$ c. 1,270) (drawing).
C, *Choisya ternata*, first meiotic metaphase, pollen mother cell, $n = 27$ ($\times$ c. 1,270).

enough suction would be exerted to fill the alveoli with a transudate from the capillaries. Means for keeping the surface tension low must therefore be part of the design of the lung. It is thus evident that the alveoli are lined with an insoluble protein layer which can abolish the tension of the alveolar surface.

40- μ bubbles squeezed from a fragment of the artificially inflated lung of a mature foetal rabbit (within a few seconds of inflation) and kept in air-saturated saline usually contract by about 30 per cent in diameter and then remain stable. The layer is therefore initially formed by rapid surface adsorption from a substance already present in the foetal lung. It probably matures somewhat during the first few hours after birth. A layer is likewise rapidly formed when an adult lung which has been consolidated is re-expanded.

By none of the many methods tried have small bubbles stable in air-saturated saline been regularly produced from blood or from amniotic fluid. The layer is thus not formed from either of these liquids, or from a transudate from the blood. Such bubbles have been formed from nasal (but not, so far, from tracheal) mucus; they are easily formed from a solution of an extract of hog gastric mucosa ('gastric mucin'), and from this solution also a foam resistant to silicone anti-foams has been prepared. These findings suggest that a layer of some form of mucus², secreted in the depths of the lung, is the source of the insoluble alveolar lining layer.

This communication is published by permission of the Chief Scientist, Ministry of Supply.

R. E. PATTLE

Ministry of Supply,
Chemical Defence Experimental Establishment,
Porton, Wilts.
March 3.

Drinker, C. K., "Pulmonary Oedema and Inflammation", 26 (Harv. Univ. Press, Cambridge, Mass., 1950). Courtice, F. C., and Korner, P. I., *Aust. J. Exp. Biol. and Med. Sci.*, 30, 511 (1952).

² Macklin, C. C., *Lancet*, i, 1099 (1954).

A Micromethod for Determination of the Circulating Blood Volume in Chick Embryos

WE have devised a method for estimating the circulating blood volume in avian embryos from somite stages up to hatching, that is, practically from the onset of circulation in the embryo. Earlier publications on the subject^{1,2} are concerned with the second half of foetal life only.

In order to determine the volume of circulating plasma in chick embryos 1 per cent Geigy blue solution (Evans's blue) was used. The dye was dissolved in Ringer solution. The pigment was slowly injected by means of a glass micropipette, the bevelled orifice of which measured 50-150 microns in diameter. Injection (under Greenough binocular) was carried out on the second day of incubation into the sinus terminalis close by the anterior vitelline vein, from the third day until the fifth into the vitelline veins, from the sixth up to the nineteenth day into the allantoic veins, and the twentieth day as well as the first postembryonic day into the internal jugular vein. The position of veins in embryonic membranes makes possible a controlled intravascular injection. From the fourteenth day onwards, the necessary preparation of perivascular connective tissue was performed.

The amount of dye in the micropipette was determined by calibration with mercury (to 0.01 mgm.) or weighed directly (to 0.1 mgm.); we use 1 mgm. per 1 microlitre. The micropipette was emptied into the vein and rinsed with redrawn blood within 30-60 sec. The dye circulated for 3 min. and in the next 30-60 sec. the blood sample was taken. From the very moment of injection of the dye to completion of the sample (5 min.), the tip of the pipette did not leave the vein. The correct amount of solution which did not cause any disturbance in the circulation of plasma was determined. On average, the following amounts of dye solution were injected: day 2, 0.07 mgm.; day 3, 1 mgm.; day 4, 1.3 mgm.; day 5, 2.4 mgm.; day 6, 3.5 mgm.; day 7, 4.4 mgm.; days 8 and 9, 6.5 mgm.; days 10-13, 10-15 mgm.; days 14-18, 15-20 mgm.; and from day 19 to the first postembryonic day, 20-30 mgm. This amount represented 1-2 per cent of the total blood volume in the embryonated egg. From day 14 onwards, a tiny drop of heparin anticoagulant was placed in the bulb of the micropipette in order to prevent coagulation of the blood sample. This method enabled us to determine the amount of circulating plasma in the individual embryos except for day 2, when it was necessary to use pooled samples (six embryos).

The greater part of the sample was centrifuged in a capillary tube, and the portion of the capillary containing the dyed plasma was cut off. 5-50 mgm. of plasma was mixed with 1 ml. (up to day 5 with 0.5 ml.) of distilled water. The sample was put into a microcuvette (optical length 10.0 mm., content 220 μ lit.) and the extinction read on a Pulfrich stufenphotometer at the wave-length 610 m μ . The

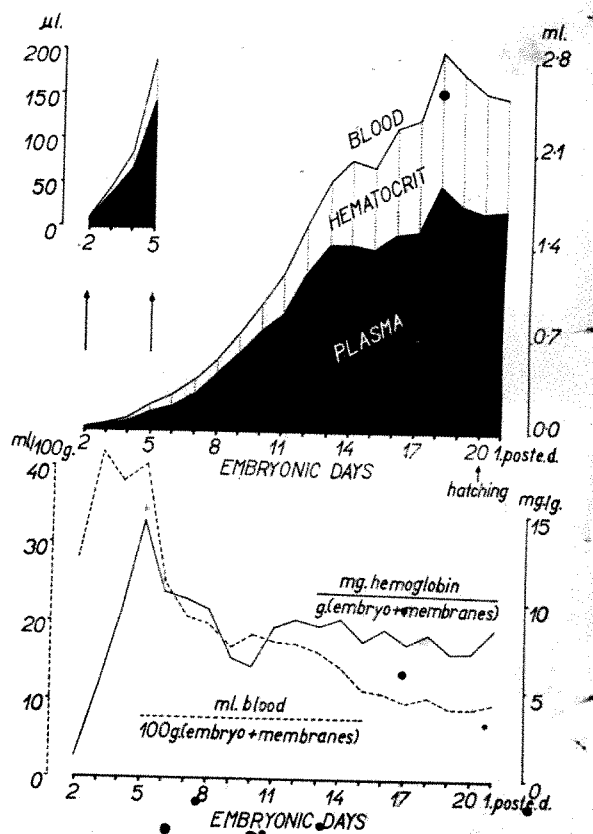


Fig. 1

amount of dye in the sample was determined from a calibration curve. The relationship between extinction and dye concentration is linear. The volume of circulating plasma was calculated from the dilution of the dye; the circulating blood volume from the plasma volume and the haematocrit.

Glass capillaries (diameter 0.1–1 mm., length 50 mm.) were filled with blood, one end sealed in fine-pointed flame, centrifuged for 15 min. and the haematocrit values measured in millimetres. These results were compared with values obtained by usual haematocrit tubes; the agreement was excellent³. In addition to these estimations, the same sample served for the determination of erythrocyte count and haemoglobin. Geigy blue does not interfere with the determination of haemoglobin. Up to day 7, it is essential to measure erythrocyte count, haematocrit and haemoglobin separately, because Geigy blue causes sludging of primitive erythrocytes, whereas plasma circulation remains undisturbed.

Embryos were weighed; on the second and third days, respectively, the somite stage was estimated supravitaly by neutral red (25 and 39 somites on average). For allantois and corrected yolk sac weights, Byerly's data⁴ were used. The haematocrit values were not corrected; exsanguinated embryos were weighed. For this reason we are obliged to take the absolute as well as the relative data in Fig. 1 as maximal.

Each day of incubation, twelve embryos (White Leghorn) were used. The upper part of Fig. 1 shows the absolute values of plasma volume, haematocrit and blood volume, while in the lower part the relative amounts of the circulating blood and haemoglobin are given. A full account of our experiments is to be published elsewhere⁵; meanwhile, we wish to emphasize the continuous decrease of the relative blood volume, in contrast to the fairly constant relative haemoglobin from day 8 onwards. Our results also make it possible to calculate the basic characteristics of the average erythrocyte from the second day of incubation until hatching.

Z. RYCHTER
M. KOPECKÝ
L. LEMEŽ

Department of Anatomy,
Charles University,
Prague.
Feb. 9.

¹ Barcroft, J., "Researches on Pre-natal Life", 1 (Oxford, 1946).

² Yospe-Purer, Yona, Fendrich, J., and Davies, A. M., *Amer. J. Physiol.*, 175, 178 (1953).

³ Rychter, Z., *Čs. morfologie* (in the press).

⁴ Byerly, T. C., *J. Exp. Biol.*, 9, 15 (1932).

⁵ Rychter, Z., Kopecký, M., and Lemež, L., *Čs. morfologie* (in the press).

Neurohumoral Control of the Release of Adrenocorticotrophic Hormone

SINCE the stimuli which activate the anterior lobe of the pituitary gland to discharge adrenocorticotrophin (emotional stress, several drugs such as adrenaline, and so on) elicit a parallel release of antidiuretic hormone from the hypothalamus and from the neurohypophysis¹, we thought it worth while to investigate the possibility that posterior pituitary hormones may play a part in the regulation of the secretion of adrenocorticotrophic hormone from the adenohypophysis.

Since 1951, evidence was given that both the antidiuretic and the oxytocic hormones from posterior

pituitary may produce a release of adrenocorticotrophic hormone from the anterior lobe. In normal dogs the intravenous injection of small amounts (1 U./kgm.) of both oxytocic and antidiuretic hormones activates the adenohypophysis to discharge adrenocorticotrophic hormone and thereafter produces eosinopenia; doses even smaller than these (0.1 U./kgm.) produce a greater eosinopenia when injected directly in the cerebrospinal fluid².

In normal rats the intravenous or intramuscular administration of small amounts of posterior pituitary hormones (0.3 U./rat) brings about a fall in adrenal ascorbic acid content, comparable in degree and in its time relationship to that produced by adrenocorticotrophic hormone³; ascorbic acid depletion is not due to contamination with hormone of the extracts used, since it does not occur in hypophysectomized rats³.

Further proof that posterior pituitary hormones may activate the anterior lobe was furnished by experiments demonstrating that in normal dogs a marked and abrupt elevation in blood thyrotrophic hormone-level follows the injection of small amounts of posterior pituitary hormones (0.2 U./kgm.) into the cerebrospinal fluid⁴.

Experiments now in progress show that posterior pituitary hormones may produce also a discharge of luteotrophin from the anterior pituitary.

The evidence given in the papers mentioned suggests that the hypothalamus may control pituitary adrenocorticotrophic hormone output by release of antidiuretic and/or oxytocic hormone(s), and that posterior pituitary hormones may be the unidentified 'neurohormone' reaching the adenohypophysis through the portal vessels, as suggested by Harris's experiments⁵.

Our findings have been confirmed by several authors⁶, and our hypothesis has been accepted and supported also by Mirsky *et al.*⁷ and by McCann *et al.*⁸. Clear-cut evidence has been provided now by Rothballer⁹ and by Barnett¹⁰, who have shown that after exposure of rats to pain stimuli the neurosecretory material found in the hypothalamo-hypophyseal system is depleted from the median eminence and from the infundibular process into the portal vessels, to reach the adenohypophysis.

Further support for our hypothesis is provided by the determination of adrenal cholesterol content in rats receiving posterior pituitary hormones.

Forty-eight male albino rats (100–150 gm.) were divided into three groups: the first received oxytocic hormone (0.3 U./rat 'Pitocin', Parke-Davis), the second antidiuretic hormone (0.3 U./rat 'Pitressin', Parke-Davis), the third 0.2 ml. of saline solution. The hormones were diluted to 0.2 ml. of saline solution and injected subcutaneously. Total adrenal cholesterol determinations were carried out by the method of Sperry and Webb¹¹.

The results obtained are summarized in Fig. 1. Antidiuretic hormone produces a significant fall of adrenal cholesterol; oxytocin decreases adrenal cholesterol, too, but this fall is not significant. When the same experiment was repeated on hypophysectomized rats, the results illustrated in Fig. 2 were obtained; there was no depletion of cholesterol in hypophysectomized rats after administration of either antidiuretic or oxytocic hormone. This demonstrates that cholesterol depletion after injection of posterior pituitary hormones is not due to contamination of the materials injected with adrenocorticotrophic hormone.

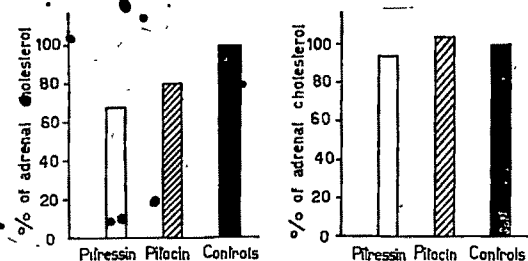


Fig. 1

Fig. 2

Fig. 1. Effect of the subcutaneous injection of posterior pituitary hormones on adrenal cholesterol of normal rats

Fig. 2. Effect of the subcutaneous injection of posterior pituitary hormones on adrenal cholesterol of hypophysectomized rats

These results confirm that posterior pituitary hormones may activate the anterior lobe of the pituitary gland to discharge adrenocorticotrophic hormone and indicate that antidiuretic hormone of the posterior pituitary may be considered as a possible neurohumoral transmitting agent.

Experiments to be published, carried out on hypophysectomized rats bearing pituitary transplants in the anterior chamber of the eye, demonstrate that the action of posterior pituitary hormones on the adeno-hypophysis is direct and not mediated through nerve centres.

L. MARTINI
C. MORPURGO

Department of Pharmacology,
University of Milan.
Feb. 1.

¹ Verney, E. B., *Brit. Med. J.*, 11, 119 (1948). Martini, L., and Rovati, V., *Boll. Soc. Ital. Biol. Sper.*, 28, 1593 (1952).

² Fraja, A., and Martini, L., *Boll. Soc. Ital. Biol. Sper.*, 28, 407 (1952).

³ Bertelli, A., and Martini, L., *Atti Soc. Lomb. Sci. Med. Biol.*, 7, 430 (1952).

⁴ Fraja, A., and Martini, L., *Arch. Int. Pharmacodyn.*, 93, 167 (1953).

⁵ Harris, G. W., *Ciba Found. Coll. Endocrinology*, 4, 106 (1952).

⁶ Frank, H. R., *Arzneimittelforschung*, 2, 506 (1952). Gorl, E., *Atti Soc. Lomb. Sci. Med. Biol.*, 8, 257 (1953).

⁷ Mirsky, I. A., Stein, M., and Paulisch, G., *Endocrin.*, 55, 28 (1954).

⁸ McCann, S. M., and Brobeck, J. R., *Proc. Soc. Exp. Biol. Med.*, 87, 818 (1954).

⁹ Rothballer, A. B., *Anat. Rec.*, 115, 21 (1953).

¹⁰ Barnett, B. J., *Endocrin.*, 55, 484 (1954).

¹¹ Sperry, W. M., and Webb, M., *J. Biol. Chem.*, 187, 97 (1950).

Simultaneous Evaluation of Circulating Eosinophils, Polymorphonuclears and Lymphocytes by Phase-contrast Microscopy

WHILE counting blood eosinophils, it may be very useful to determine the corresponding numbers of the other white cells in the same preparation. This can be effected in a simple and reliable way, by using phase-contrast microscopy and a modified Zollikofer's solution¹, composed of 1 ml. yellow eosin (2 per cent aqueous solution, kept in a refrigerator), 3 ml. formalin (40 per cent, neutralized with calcium carbonate) and distilled water to make up 100 ml.

In order to count the eosinophils in dogs, rats and man, we used the following technique: the blood sample is drawn quickly into a micropipette, carefully adjusted to the mark, and, diluted to 1/20 in a precisely measured amount of the fluid described, contained in a small test-tube (aimless, approximately 7 mm. x 50 mm., commonly used in serological agglutination tests). As they occur almost instantly, fixation and staining need not be waited for; on the other hand, immediate counting is not essential,

provided evaporation of the blood-fluid mixture is prevented.

After a few seconds of gentle shaking by hand, the mixture is run into a Fuchs-Rosenthal counting chamber (dimensions: height 0.2 mm.; counting surface, two rulings of 4 mm. x 4 mm., large squares of 1 mm. side, small squares of 1/4 mm. side; four rulings were always counted for one evaluation), where the eosinophils appear bright red on a clear background, whereas the other unstained white blood cells are barely visible as 'ghosts'.

By switching over from bright-field to phase-contrast, and preferably from a lower to a higher magnification, in a suitably equipped microscope, those 'ghosts' become so clearly defined that distinguishing between polymorphonuclears and lymphocytes becomes readily possible. Also the blood platelets are well shown up; their degree of agglutination provides an index of the clotting tendency in the blood sample at the moment it was withdrawn, being minimal in the most quickly secured, and therefore the most reliable, specimens.

The enumeration of the white blood cells can be effected by counting a row of 16 small squares, multiplying the results by 100, and thus obtaining the number of leucocytes—polymorphonuclears and lymphocytes—per mm.³. To reduce counting variations, especially when the number of leucocytes is relatively low, two or more rows are checked.

As usual, and especially in this method, one has to wait long enough for the particles to settle down on the bottom of the counting chamber. To ascertain comparability of results, it is, of course, highly advisable to observe a standard routine for every step of the procedure and to avoid contamination with foreign particles.

Whenever an immediate count is not carried out, two precautions are of the utmost importance: (1) the small test-tubes must be kept closed, preferably with a rubber cork; (2) mechanical shaking for one to

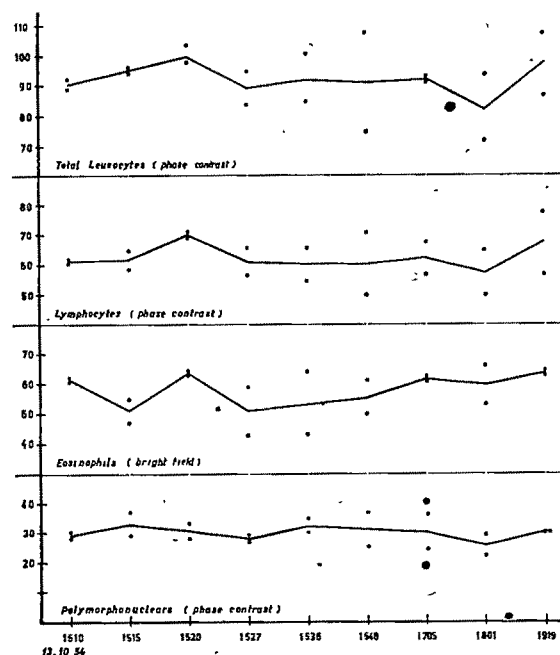


Fig. 1. 'Early' differential counts of white blood cells as a function of time (two counts per chamber, curve of means). Cardiac puncture at 1503

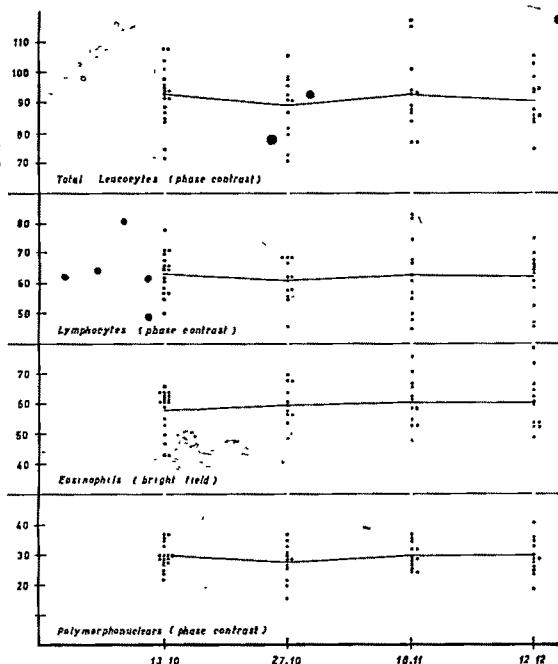


Fig. 2. 'Late' differential counts of white blood cells at two-weekly intervals

two minutes is necessary before running the fluid into the counting chamber. As will be proved elsewhere in more detail, not so much the evaporation itself but the agglutination of the cells and adhesion to the glass wall at the edge of the evaporating solution must be considered disturbing factors.

Repeated counts and statistical analysis of the results have demonstrated that the white blood cell counts obtained by this method agree with those found by classical procedures and, as is also the case for the eosinophils, show no significant differences in the same specimen stored for at least two months, and probably for even longer periods.

Studying the second point, we found, after several trials, the most adequate technique to be the following. A 20-ml. syringe was filled with modified Zollikofer's fluid and 1 ml. blood was then drawn into it by cardiac puncture of an ether-anesthetized rat. To exclude very early changes in the cell numbers, the preparation was—after thorough shaking of the syringe and changing the needle—run directly into the counting chambers. Counting was started as soon as possible, and repeated at steadily increasing intervals up to four hours afterwards. Using the rank correlation method of Kendall², no significant trend was found for any cell type, as illustrated also by the curve in Fig. 1. The rest of the preparation was kept in small test-tubes, closed with rubber corks, and countings were repeated about every two weeks. Also in this case there were no significant differences in the results (Fig. 2).

Although a comparative study of other methods is proceeding, the most important advantages of our method can already be summarized here: (1) the absolute and relative counts of the different white blood cells are obtained in one and the same preparation; (2) the cells are extremely well preserved qualitatively and quantitatively for longer periods than has been claimed before in the literature—this might prove useful in a routine laboratory dealing with post-mortem samples; (3) the counts may be

made as soon as the blood sample is taken; (4) by introducing small test-tubes in the diluting procedure, only one pipette is needed, and it can be used for all the blood samples.

These investigations were supported by a grant from the Pharmaceutical Laboratories (Dr. J. G. Janssen), Turnhout, Belgium.

P. J. CARPENTIER

Research Laboratory,
Department of Gynaecology and Obstetrics,
University of Ghent.
Jan. 1.

¹ Zollikofer, R., *Z. Mikrosk. u. mikr. Tech.*, 17, 313 (1900).

² Kendall, M. G., "Rank Correlation Methods", 37 (1948).

Effect of the Rumen on Dietary Fat

EARLIER experiments by Thomas, Culbertson and Beard¹ have shown that feeding liberal allowances of highly unsaturated oils to steer calves over a period of 260 days was without effect on the mean unsaturation of the body fat. It has similarly been shown by Shorland and co-workers²⁻⁵ that the main dietary fatty constituent of pasture-fed animals—linolenic acid—although present in non-ruminants in quantity, appears only in traces in the depot fats of ruminants. It has been suggested by one of us that differences in fatty acid composition between the fats of ruminants and non-ruminants might be attributed to modification of the dietary fat in the rumen^{2,5}. Reiser⁶ found that linseed oil emulsions incubated with rumen contents showed a diminution in linolenic acid content with a corresponding increase in linoleic acid, indicating the hydrogenation of linolenic acid to linoleic acid. Hartman, Shorland and McDonald⁷ have suggested that such hydrogenation would explain the presence of appreciable amounts (3.5–11.2 per cent of *trans* acids in ruminant fats and their absence in the fats of non-ruminants).

More recently, in association with the Grasslands Division, Palmerston North, of the New Zealand Department of Scientific and Industrial Research, we have studied the effect of rumen contents on pasture fatty acids and on linolenic acid, and results now recorded serve to indicate the profound effect of the rumen on the dietary fat.

As previously observed³, the predominant fatty constituent of pasture (cf. Table 1) is linolenic (C₁₈ triene) acid; but in the rumen fat, as in the ruminant depot fat, this acid is only a minor constituent. In the rumen the dietary fat has undergone a profound change, so that it now resembles depot fat. Particularly noteworthy are the high proportions of stearic acid. Hilditch⁸ has already suggested that the relatively high proportions of stearic acid glycerides in ruminant depot fats could arise by hydrogenation *in situ* of preformed oleo-glycerides. The

Table 1. COMPARISON BETWEEN FATTY ACID COMPOSITION OF CLOVER-RICH PASTURE AND OF RUMEN CONTENTS OF SHEEP GRAZING THEREON (Fatty acids weight per cent)

	Saturated				Unsaturated			
	C ₁₄	C ₁₆	C ₁₈	as C ₁₈	C ₁₄	C ₁₆	mono- C ₁₈	tri-ene
Clover-rich pasture	—	2.9	2.8	3.9	—	7.9	9.5	58.9
Rumen contents of sheep	1.2	16.9	48.5	5.8	0.2	1.8	19.4	2.9

present work, while by no means excluding this possibility, shows that stearic acid could arise also from the hydrogenation of dietary linolenic acid present as glyceride or as free acid in the rumen.

The results recorded in Table 1 do not exclude the possibility that the dietary fat is metabolized in the rumen and afterwards resynthesized. However, the following results obtained by incubation in a carbon dioxide atmosphere of 2.58 gm. linolenic acid (85 per cent pure, prepared from conophor oil) with rumen contents (144 ml.) for three days at 37° would suggest that this is not so to any marked degree.

The low content of fatty acids in the blank (0.47 gm.) and the relatively high proportion of fatty acids in the sample (2.46 gm.) remaining at the end of the experiment are consistent with the view that the fatty acids in the rumen are not appreciably destroyed, but that linolenic acid is hydrogenated to monoene as well as to diene acids to such an extent that, of the 2.19 gm. originally present, only 0.28 gm. remained. These results accord with Reiser's⁶ view that rumen contents act as a powerful hydrogenating medium; but whereas he has suggested that linolenic acid is merely converted to linoleic acid, our work shows that the hydrogenation proceeds further to the monoene stage or to stearic acid (cf. also Table 1). The results in Table 2 establish also the accompanying formation of *trans* acids (cf. Hartman *et al.*⁷) during hydrogenation.

Table 2. EFFECT OF SHEEP RUMEN CONTENTS ON LINOLENIC ACID
(Weights of fatty acids in gm.)

	Satur- ated	Monoene	Unsaturated		Diene (b)	Triene (b)	<i>Trans</i>
			Diene (a)	Triene (a)			
Rumen contents + linolenic acid (sample)	0.41	1.23	trace	0.28	0.50	0.04	0.26
Rumen contents alone (Blank)	0.32	0.15	"	trace	trace	trace	Not de- tected
Difference	0.09	1.08	—	0.28	0.50	0.04	0.26

(a) = non-conjugated, (b) = conjugated.

Work in progress shows that rumen contents also effectively hydrogenate linoleic and oleic acids. Details of this and of other experiments will be reported elsewhere.

The present results illustrate how the action of the rumen may modify the nature of the dietary fat before absorption and deposition. The extensive hydrogenation of the dietary fat in the rumen not only gives rise to *trans* acids, as earlier indicated by Hartman *et al.*⁷, but it also explains the relative stability of the composition of ruminant depot fats independently of the nature of the dietary fat.

F. B. SHORLAND

R. O. WEENINK

A. T. JOHNS

Fats Research Laboratory, Grasslands Division,
Wellington, Palmerston North,
Department of Scientific and Industrial Research,
New Zealand.

Jan. 27.

¹ Thomas, B. H., Gilbertson, C. C., and Beard, F., *Amer. Soc. Animal Production, Rec. Proc.*, 27th Annual Meeting, 193 (1934).

² Shorland, F. B., *Nature*, 165, 766 (1950).

³ Brooker, E. G., and Shorland, F. B., *Biochem. J.*, 46, 80 (1950).

⁴ Shorland, F. B., Bruce, L. W., and Jessop, A. S., *Biochem. J.*, 52, 400 (1952).

⁵ Shorland, F. B., *J. Sci. Food and Agric.*, 4, 497 (1953).

⁶ Reiser, R., *Fed. Proc.*, 10, 236 (1951).

⁷ Hartman, L., Shorland, F. B., and McDonald, T. R. C., *Nature*, 174, 185 (1954).

⁸ Hilditch, T. R., *Amer. Oil Chem. Soc.*, 26, 41 (1949).

Behaviour of the Ground Substance of Rabbit Dermis in the Course of Skin Treatment with 3-4 Benzpyrene

It has been repeatedly observed that in the course of cell-growth processes of various nature (embryonic tissues¹, regenerating tissues in adult animals², tumours of epithelial and mesenchymal origin³, etc.) the metachromatic substance is demonstrable, or increased if pre-existing, in the intercellular component of tissues. A relationship seems to exist between cell-growth processes and production of metachromatic substance in surrounding connective tissues; but its nature is unknown. We have therefore studied the genesis of intercellular metachromatic substances in the course of experimental oncogenesis, in order to establish whether their appearance is secondary to the already formed tumour or prior to its onset.

For this purpose seven albino rabbits were used. Their backs were carefully shaved; an area of approximately 15 cm. × 6 cm. on the right flank was painted with a 0.3 per cent solution of 3-4 benzpyrene in acetone (prepared by the Hoffman-La Roche firm of Basle), and an equally large area on the left flank was treated with acetone alone. Four applications were given at 3-day intervals. Three days after the last application, a skin fragment was removed from both benzpyrene- and acetone-treated surfaces. The fragments were fixed in ethanol at 90°. Microtome sections were stained with toluidine blue according to the usual technique for the demonstration of metachromatic substance.

The sections from the benzpyrene-treated skin presented, in addition to the epithelial alterations which are known to be characteristic of the early stages of skin carcinogenesis (hyperplasia of hair follicles, etc.), a remarkable increase of metachromatic substance of the dermis. This substance was especially evident in the upper layers of the dermis, particularly around the hyperplastic follicles. Nevertheless, some preparations showed that the metachromatic substance of the dermis was evidently increased in a uniform manner, even in the sites most remote from the follicles. The metachromatic substance became gradually less evident towards the skin deeper zones, so as to give a stain equal to that presented by the sections from the acetone-treated skin.

From these results it seems reasonable to conclude that the appearance of metachromatic substance is a consequence of the treatment with material which will later induce the onset of the tumour, rather than being due to the presence of the tumour itself, since at this stage of treatment there is no evidence of malignant metamorphosis in the epithelial cells. One cannot exclude also, at the present state of investigations, that in this case the increase of metachromatic substance, which occurs at the same time as the hyperplasia of epithelial structures, may have the same unknown significance as this phenomenon has in all the above-mentioned instances, that is, when the appearance of metachromatic substance is observed in the course of cell-growth processes.

This matter, however, seems to be significant and to deserve further investigations, because it is desirable to attempt a determination of the chemical nature of the metachromatic substance which is produced as a result of carcinogenic treatment.

In a recent paper by Sylvén⁴, observations are reported which apparently deal with the same subject: he says that "In healing wounds the meta-chromatic material appeared simultaneously with a sharp decrease in mast cell numbers, and this is also illustrated during experimental mouse skin carcinogenesis". In the absence of the full account of this work, it is not possible to state whether his results are in accordance with ours.

This investigation has been carried out under the auspices of the Damon Runyon Memorial Fund for Cancer Research, New York.

G. PRODI

Institute of General Pathology.
University of Bologna.

¹ Holmgren, H., *Anat. Anz.*, 88, 246 (1939).

² Sylvén, B., *Acta Chir. Scand.*, 88, Supp., 66 (1941). Campani, M., and Reggiani, O., *J. Path. and Bact.*, 62, 563 (1950).

³ Sylvén, B., *Klin. Wschr.*, 17, 1545 (1938). Negri, L., and Ferrante, R., *Arch. De Vecchi*, 12, 373 (1949). Sylvén, B., *Acta Radiol.*, 32, 11 (1949).

⁴ Sylvén, B., *Acta*, 10, 169 (1954)

Tumours induced in Rats with 4'-Fluoro-4-Aminodiphenyl

We have made the following suggestions to explain the incidence and location of the tumours produced in rats with 4-aminodiphenyl and some of its nuclear methylated derivatives¹: First, that in each instance the effective carcinogen is the corresponding *ortho*-hydroxy amine, formed in the liver and excreted in the bile; secondly, that 4-aminodiphenyl itself is largely metabolized to the 4'-hydroxy derivative and that little of the *ortho*-hydroxy amine, 3-hydroxy-4-aminodiphenyl, is formed; and finally, that in the metabolism of the more actively carcinogenic derivatives of 4-aminodiphenyl containing a methyl substituent in the 3 position, relatively more of the corresponding *ortho*-hydroxy amines are produced.

Metabolic studies are in progress; in the meantime, we have sought indirect evidence in support of these ideas by preparing and testing 4'-fluoro-4-aminodiphenyl. With this substance the possibility of metabolic hydroxylation in the 4'-position is excluded by the presence there of firmly bound fluorine, and a relatively high yield of the corresponding 3-hydroxy-4-aminodiphenyl may be expected. If our theories are correct, this should result in increased carcinogenic potency on the part of the fluoro derivative in comparison with the parent amine of the series.

In a first experiment, 4'-fluoro-4-aminodiphenyl was given by subcutaneous injection, in solution in arachis oil B.P., to twenty-four male albino rats of Wistar origin. Injections were made daily, Saturday and Sunday excluded. The daily dose was initially 5 mgm./100 gm. body-weight; but because of toxicity it was reduced progressively over the first seven weeks of treatment to 1 mgm./100 gm. One rat died at 48 days, and for the remainder the mean overall duration of dosing was 143 days, the mean total dose of the compound 199 mgm./100 gm., and the mean survival time 515 days (limits 381 and 626) from the start of dosing. Neoplasms were found in every one of these twenty-three animals, the number in which the following organs were primarily involved being:

Liver	22
Kidney	20 (at least 10 bilaterally)
Intestine	8 (6 large intestine only)
Pancreas	3 (exocrine adenomata)
Testis	3 (interstitial cell tumours)

In addition, one animal had lymphosarcoma, one a spindle cell sarcoma in the mediastinum and three a subcutaneous sarcoma at the site of injection of the solution.

For eleven male and eleven female rats treated similarly with 4-aminodiphenyl itself, the mean duration of dosing was 306 days; the mean total dose 456 mgm./100 gm. and the mean survival time 477 days (limits 227 and 577). Tumours attributable to the compound were found in seven male and six female rats, apart from sarcomata local to the injection site and one sarcoma of the liver probably due to *Cysticercus fasciolaris*.

From this limited comparison it would appear that, quantitatively, the 4'-fluoro derivative is more actively carcinogenic than the parent amine. However, the introduction of the fluorine atom changes the whole pattern of tumour incidence. Whereas with 4-aminodiphenyl the commonest tumours were intestinal, such being found in seven of the thirteen tumour-bearing rats, the main targets of attack with the fluoro compound were the liver and kidney.

The changes seen in the liver in the latter animals comprised a variety of abnormalities leading up to hepatomata and cholangiomata. These often occurred together, and in some instances in remarkably complex and intimate mutual relationship. The tumours of the kidney were of tubular origin and ranged in size from the microscopic to masses 1.0-2.0 cm. in diameter. They were frequently multiple but appeared relatively benign; no metastases were found. A more detailed description of these tumours and their histogenesis is in preparation.

J. A. HENDRY
J. J. MATTHEWS
A. L. WALPOLE
M. H. C. WILLIAMS

Imperial Chemical Industries, Ltd.,
Hexagon House,
Manchester 9.
April 27.

¹ Walpole, A. L., Williams, M. H. C., and Roberts, D. C., *Brit. J. Indust. Med.*, 9, 255 (1952)

Loss of Biological Efficiency of Cattle-dipping Wash containing Benzene Hexachloride

BATHS with capacities of several thousands of gallons are used in the principal cattle-raising countries in the control of ticks on cattle. The cost of the insecticide required to fill these baths is high, and the result is that they are used for one to two years, often longer, without being emptied and cleaned. As it is necessary, particularly in Africa, to dip large numbers of animals frequently, the baths become very foul. In 1946 benzene hexachloride (B.H.C.) was first used in South Africa for control; but its initial efficiency dropped rapidly in several baths, after use for a few months. Whiteall, Bradford, McHardy, Whitehead and Meerholz¹ reported inability to detect alteration in the γ -isomer content of such wash, but "the methods of chemical analyses used in their investigation were not specific for the γ -isomer" (Roulston and Hitchcock²). Technical B.H.C. containing about 13 per cent of the γ -isomer was being used, and the loss of efficiency was not proportional to the loss of total isomers. After fresh

Table 1

Isomer	Initial B.H.C. (per cent)	Final B.H.C. (per cent)	Increase in ionized Cl (per cent)
alpha	0.099	0.088	0.003
beta	0.099	0.097	nil
gamma	0.099	0.039	0.029
delta	0.039	0.075	0.007

insecticide restored initial efficiency, deterioration was then more rapid than before. Similar experience was reported wherever γ -isomer was only slightly in excess of that required for biological control. In Australia, where a much higher concentration was used; loss of efficiency was not observed in the field, although recent determinations by the partition chromatographic method show disproportionate loss of γ -isomer with loss of total isomers. Thus we have found in the B.H.C. contained in six samples from two baths in Queensland 2.9–7.8 per cent γ -isomer. The γ -isomer content of the B.H.C. used for these baths was approximately 12 per cent. Similar results are reported by Roulston and Hitchcock³.

The cause of the loss of biological efficiency has been investigated in these laboratories for several years, and it has been shown that it is due to direct or indirect action by bacteria on the γ -isomer. Conditions in a cattle-dipping bath were imitated in a laboratory by adding fine soil, cattle faeces, urine and extracts of scrapings from cattle hide at weekly intervals to suspensions of finely ground B.H.C. Initially, technical B.H.C. (13 per cent γ -isomer) was used and biological efficiency was tested, using *Calandra granaria*. After a few months the loss was not proportional to the loss of total B.H.C. determined chemically by dehydrochlorination with alkali. Experiments with pure single isomers showed the γ -isomer to disappear at nearly six times the rate for the α -isomer. The results of this series of experiments after 68 weeks are given in Table 1.

Losses of unchanged isomers occasioned by volatility during the period of these experiments were estimated to be: α , 0.004 per cent; β , nil; γ , 0.007 per cent and δ , 0.006 per cent.

The rates of decomposition of the α - and γ -isomers differed from those of these isomers when they are dehydrochlorinated by treatment with alkali³. Nakajima, Inagaki and Tati⁴ found the γ -isomer gives benzene at a greater rate than the α -isomer by the action of zinc powder in aqueous alcohol.

Further evidence of the unusual mechanism of breakdown came from the observed more rapid increase in the ionized chloride contents of preparations of the γ -isomer than of those of the α -isomer. After 50–70 weeks, five to six atoms of ionized chlorine had been obtained from each molecule of the γ -isomer destroyed, but approximately only three from each of the α -isomer. The results of one series of experiments are given in Table 1, column 4.

Bacterial action appeared to be the only explanation for these results. A range of organisms was therefore grown with pure γ -isomer in peptone-serum

broth; the growth of the anaerobes particularly was accompanied by substantial destruction of benzene hexachloride.

If the hydrogen produced by certain bacteria could dechlorinate B.H.C., an explanation for the observed facts would be forthcoming. Gases produced from cultures of *Cl. sporogenes* and *B. coli* in suspensions of pure γ -isomer were led through a mixture of nitric and sulphuric acids, and at intervals nitrogen was passed through the cultures and apparatus. Traces of benzene were usually detected in the head space within seven days, with further quantities appearing regularly until the growth-rate of the bacteria became slow. The benzene was estimated by the method of Schechter and Hornstein⁵. In addition to the *m*-dinitrobenzene recovered, a small amount of dinitro-chlorobenzene was also detected in one experiment; this was identified by the colour produced with pyridine and sodium hydroxide⁶. Benzene had also been detected in samples of cattle wash obtained from South Africa, and no benzene was produced in controls to which no B.H.C. was added.

It appears probable that hydrogen produced by bacteria brings about dechlorination of the γ -isomer and, to a slight extent, of the α -isomer.

Confirmation appears to come from experiments in which, after adding fouling materials to suspensions of benzene hexachloride (11–12 per cent γ -isomer), sodium chlorate (0.1 per cent) was added to each preparation initially and at monthly intervals. To a control preparation no chlorate was added. The results of analysis after fifty weeks are given in Table 2.

This work has been carried out by a number of entomological, chemical and bacteriological workers in these laboratories with the co-operation of their colleagues in South Africa and Australia. It is proposed to publish fuller results elsewhere.

JAMES ALLAN

Cooper Technical Bureau,
Berkhamsted, Herts.
March 4.

¹ Whitnall, A. B. M., Bradford, B., McHardy, W., Whitehead, G. B., and Meerholz, F., *S. Afric. Sci.*, 2, 112 (1948).

² Roulston, W. J., and Hitchcock, L. F., *Nature*, 172, 546 (1953).

³ Cristol, S. J., *J. Amer. Chem. Soc.*, 69, 338 (1947).

⁴ Nakajima, M., Inagaki, K., and Tati, T., *Botyu Kagaku*, 16, 107 (1951).

⁵ Schechter, M. S., and Hornstein, G., *Anal. Chem.*, 24, 544 (1952).

⁶ Ginzburg, S. L., *Khim. Prom. N.Z.*, 23 (1947).

Table 2

	Initial total B.H.C. (per cent)	Final B.H.C. (per cent)	Gamma isomer recovered unchanged (per cent)
Control (no chlorate)	0.103	0.084	18
Exp. 1 (chlorate added)	0.160	0.098	88
Exp. 2 (chlorate added)	0.101	0.097	82

Biochemical Variations in Inbred Mice

ATTENTION has been directed to skeletal variations within inbred mice strains by Grüneberg¹ and by McLaren and Michie². The latter workers have surveyed most of the available substrains of *C₃H* mice and have found that they fall into two general categories having either five or six lumbar vertebrae. In the course of studies on the response of liver β -glucuronidase to hormone injections, it has now been found that there are two quite distinct levels of this enzyme in certain *C₃H* substrains, and that this difference represents a genetical variation in the *C₃H* strain.

Fishman and Farmelant³ and Law, Morrow and Greenspan⁴ have previously observed that there are two general levels of activity in inbred strains, a

Table 1

C_3H substrain	Liver glucuronidase activity
Two substrains derived before 1938 in the United States	220
Imperial Cancer Research Fund (1941)	250
Leeds (1942)	220
Glasgow (1948)	300
Birmingham (1950)	2,910
Chester Beatty (present stock)	3,150
	2,520

'high' level of about 3,000-4,000 units in most strains tested, but also a 'low' level, 250-400 units, in C_3H and AKR strains (units: $\mu\text{gm. phenolphthalein liberated from phenolphthalein glucuronide per hr. per gm. wet tissue}^6$). In Table 1 are listed the liver glucuronidase activities determined in a number of C_3H substrains at present kept in Britain. All are descended from a group of C_3H/Bi (Bar Harbor) originally supplied to the Chester Beatty Institute in 1938, the dates of separation from this line being shown in brackets.

Two substrains separated before 1942 belong to the expected low group; but the other three substrains, including the original line, have high glucuronidase levels. It would therefore appear that some change or mutation, which finds expression as this difference in enzyme activity, took place in the Chester Beatty stock between 1942 and 1948. In view of these observations the possibility that other similar biochemical variations in inbred strains may occur must be taken into account when comparing results obtained on supposedly 'pure' strains by different workers.

It is not known in this case whether there is any difference in the incidence of spontaneous mammary tumours in these 'high' and 'low' substrains; but this is being investigated. By crossing a high strain (Strong A) with a low one (C_3H), Law *et al.*⁴ showed that the presence of high glucuronidase activity was associated with a single dominant gene. Cross-breeding experiments between 'high' and 'low' C_3H substrains and between C_{17} (high) and C_3H (low) have confirmed this observation.

I wish to thank Drs. J. Craigie, L. Foulds and P. R. Peacock, who supplied mice from their stocks for measurement, and Dr. Anne McLaren for supplying hybrid mice and information about the origin of the C_3H substrains prior to publication³.

D. HAMER

Cancer Research Laboratories,
Medical School,
Birmingham 15.
March 9.

¹ Grüneberg, H., *Nature*, 173, 675 (1954)² McLaren, A., and Michie, D., *J. Embry. Exp. Morph.*, 2, 149 (1954).³ Fishman, W. H., and Farnelant, M. H., *Endocrin*, 52, 536 (1953).⁴ Law, L. W., Morrow, A. G., and Greenspan, E. M., *J. Nat. Cancer Inst.*, 12, 900 (1952).⁵ Talalay, P., Fishman, W. H., and Huggins, C., *J. Biol. Chem.*, 166, 757 (1946).

Potentiating Action of Chlorpromazine and Reserpine

THIS laboratory has previously reported that β -diethylaminoethyl diphenylpropylacetate hydrochloride (*SKF 525-A*) potentiates the pharmacological activity of a variety of drugs by interfering with their rate of detoxication^{1,2}. Recently, we have become interested in the potentiating effects of chlorpromazine and reserpine, drugs widely used for their tranquillizing effects. Chlorpromazine is reported

Table 1. INFLUENCE OF CHLORPROMAZINE ON DURATION OF ACTION AND METABOLISM OF HEXOBARBITONE AND ETHANOL IN MICE. Adult male mice received, intraperitoneally, hexobarbitone (100 mgm./kgm.) or ethanol (4 gm./kgm. in 50 per cent solution) together with chlorpromazine (5 mgm./kgm.). Mice given the hypnotics without chlorpromazine served as controls. The animals assayed for hexobarbitone were killed 20 min. after drug administration; those assayed for ethanol were killed after 30 min. Figures in brackets refer to number of animals in each series

Drug	Duration of hypnosis*† (min.)		Drug metabolized at death† (per cent)	
	Controls	Chlorpromazine treated	Controls	Chlorpromazine treated
Hexobarbitone	19 ± 6 (12)	46 ± 8 (12)	56 ± 4 (5)	59 ± 4 (5)
Ethanol	40 ± 9 (9)	150 ± 13 (6)	29 ± 1 (6)	28 ± 2 (6)

* Time from loss to return of righting reflex

† Mean ± standard deviation

to potentiate the action of a number of central depressant drugs, including barbiturates and ethanol³. We have been able to show that reserpine as well as chlorpromazine potentiates the hypnotic action of hexobarbitone and ethanol; and furthermore, that neither potentiating agent influences the rate of metabolic transformation of the hypnotics but acts presumably by increasing the sensitivity of the central nervous system.

The sleeping times of mice injected with chlorpromazine and hexobarbitone were compared with those of mice injected with hexobarbitone alone. Table 1 shows that mice given 100 mgm. per kgm. of hexobarbitone together with 5 mgm. per kgm. chlorpromazine slept considerably longer than animals given only the barbiturate.

In another series of mice, the effect of chlorpromazine on the rate of bio-transformation of hexobarbitone was investigated. At a given time, the animals were killed by a blow on the head, homogenized in a Waring blender in four volumes of phosphate buffer, pH 7, and the concentration of barbiturate assayed in an aliquot of the homogenate by a method previously described¹. As shown in Table 1, chlorpromazine did not influence the metabolism of the barbiturate. Table 1 also indicates that chlorpromazine potentiated the hypnotic action of ethanol, again without changing the rate of metabolic transformation. In these experiments ethanol was assayed enzymatically in the whole animal homogenate, according to the method of Bucher and Rodetski⁴.

Chlorpromazine by itself in a dose of 5 mgm. per kgm. produced only a mild sedation, and even ten times this dose failed to produce hypnosis.

It was determined that chlorpromazine did not exert its potentiating effects by changing the uptake.

Table 2. INFLUENCE OF RESERPINE ON DURATION OF ACTION AND METABOLISM OF HEXOBARBITONE AND ETHANOL IN MICE. Adult male mice received, intraperitoneally, reserpine (5 mgm./kgm.) and, 1 hr. later, hexobarbitone (100 mgm./kgm.) or ethanol (4 gm./kgm. in 50 per cent solution). Mice given the hypnotics alone served as controls. The animals assayed for hexobarbitone were killed 30 min. after barbiturate administration; those assayed for ethanol were killed after 120 min. All animals were kept at 35° C. to minimize the hypothermia otherwise produced by pretreatment with reserpine. Figures in brackets refer to number of animals in each series

Drug	Duration of hypnosis*† (min.)		Drug metabolized at death† (per cent)	
	Controls	Reserpine treated	Controls	Reserpine treated
Hexobarbitone	19 ± 6 (12)	68 ± 14 (7)	46 ± 3 (5)	48 ± 3 (3)
Ethanol	40 ± 9 (9)	All > 300 (6)	48 ± 3 (5)	45 ± 6 (5)

* Time from loss to return of righting reflex

† Mean ± standard deviation

of the hypnotics by the brain. Animals killed at various times after injection of the hypnotics showed no significant difference in the concentration of barbiturate or alcohol in the brain, regardless of whether or not the animals had also received chlorpromazine. This indicated that the effects of the potentiator did not result from an increased concentration of the hypnotics in the brain.

Reserpine, which exerts tranquillizing effects similar to those observed with chlorpromazine, was also found to potentiate markedly the effects of hexobarbitone and ethanol. Its effect on the latter compound was especially striking (Table 2). Like chlorpromazine, reserpine did not affect the rate of bio-transformation of the two hypnotics (Table 2) or alter their uptake by the brain.

The mode of potentiation induced by chlorpromazine and reserpine is obviously different from that of *SKF 525-A*. This difference was shown in another way. When *SKF 525-A* was given intravenously to mice or dogs which had just recovered from hypnosis induced by hexobarbitone, the animals were not visibly affected; but if chlorpromazine was given, the animals reverted almost immediately to a deep hypnosis. This shows that chlorpromazine causes subhypnotic amounts of hexobarbitone to become hypnotic, and is therefore a true potentiator, in contrast to *SKF 525-A*, which acts merely as a prolonging agent.

BERNARD B. BRODIE
PARKHURST A. SHORE
STANLEY L. SILVER

Laboratory of Chemical Pharmacology,
National Heart Institute,
National Institutes of Health,
Bethesda, Md.

ROBERT PULVER
Geigy Company, Basle.
April 6.

¹ Axelrod, J., Reichenthal, J., and Brodie, B. B., *J. Pharm. and Exp. Therap.*, 112, 49 (1954).

² Cooper, J. R., Axelrod, J., and Brodie, B. B., *J. Pharm. and Exp. Therap.*, 112, 55 (1954).

³ Corvoisier, S., Fournal, J., Ducrot, R., Kolsky, M., and Koetchet, P., *Arch. int. Pharmacodyn.*, 92, 305 (1953).

⁴ Bucher, T., and Rodetski, M., *Klin. Wochensh.*, 29, 615 (1951).

Phosphorylase Activity in Relation to the Layering of Starch Granules

ARTHUR MEYER firmly believed that the layering of starch granules corresponded to the alternation of day and night, and this belief is still shared by the authors of modern text-books.¹ If this were true, then layers should disappear when starch granules develop under constant outer conditions of illumination, temperature and moisture. The only positive result of such an experiment was reported by van de Sande-Bakhuyzen for wheat. All other results appear to be negative. Salter found layers when starch granules grew in darkness, Fischer observed them after constant illumination, and according to Kuster more than two layers could be deposited during one day.

Recently, similar results have been obtained for potato starch with more accurate methods¹. Therefore, the layers must be deposited as the result of an inner rhythmic process, which, of course, might accidentally coincide with an outer rhythm. One possibility would be a fluctuation in enzymatic activity, as suggested by Bunning and Hess¹. A

day-night periodicity has been reported by Russian investigators for the phosphorylase activity of potatoes, and Shaw² mentions the possibility of a seasonal fluctuation in wheat under the influence of light.

We have measured phosphorylase activity in young actively growing potatoes of about 1.5 cm. diameter during 24-hr. periods at 6-hr. intervals. Stem cuttings of potato plants were planted in washed river sand in a greenhouse and allowed to root and form small tubers. All cuttings were grown in one container and received the same treatment. 20-80 gm. sliced tubers were treated with cold sodium hydrosulphite, extracted with 0.05 M cold citrate buffer pH 6.5 in a blender for 3 min., the extract filtered and centrifuged: 1 ml. of the extract was allowed to react with 1 ml. of substrate containing sodium fluoride, mercuric chloride, soluble starch and glucose-1-phosphate in quantities indicated by the work of Porter³. The pH was kept at 6.5 with citrate buffer and the temperature at 30° C. After 5 min., the reaction was stopped with cold trichloroacetic acid, the pH of the mixture brought down to 4 with sodium acetate, and inorganic phosphate estimated by the method of Waygood⁴. All determinations were done in duplicate. The results of two series, one starting at 6 a.m., the other starting at 10 a.m., are given in Table 1.

Table 1

Time of sampling	Phos./min./gm. fresh weight	
	I	II
0	36.6	31.2
4		
6	34.3	33.0
10		
12	32.4	33.8
16		
18	37.4	31.5
22		

The results do not show an appreciable diurnal variation of phosphorylase activity, and therefore it is more likely that the shells of a starch granule find their origin in rhythmic depositions conditioned, for example, by periodically occurring diffusion gradients.

As it has now been well established that phosphorylase is located in the plastids, but that it escapes from these structures as soon as the cells are damaged⁵, we can assume that determinations in extracts from comminuted materials give the total amount of phosphorylase available. However, as Russian investigators (cited by Weier and Stocking⁶) noticed stronger absorption of invertase by plastids in the light than in the dark, the possibility of similar rhythmic processes in the plastids of the potato cannot be entirely excluded. It is also possible that, as indicated by recent work³, phosphorylase is less involved in starch synthesis than we hitherto thought.

This work is part of an investigation supported by a grant from the South African Council for Scientific and Industrial Research.

N. P. BADENJUIZEN
M. I. MALKIN

Department of Botany,
University of the Witwatersrand,
Johannesburg.
Feb. 14.

¹ Bunning, E., and Hess, C., *Naturwiss.*, 41, 339 (1954).

² Shaw, M., *Can. J. Bot.*, 32, 523 (1954).

³ Porter, H. K., *J. Exp. Bot.*, 4, 44 (1953).

⁴ Waygood, E. R., *Can. J. Res.*, 26, 461 (1948).

⁵ Weier, T. E., and Stocking, C. R., *Bot. Rev.*, 13, 14 (1952).

⁶ Ewart, M. H., Simionovitch, D., and Briggs, D. R., *Plant Physiol.*, 29, 407 (1954).

Effect of Particle-Size on the Quantitative Determination of Quartz by X-ray Diffraction

A GEIGER-MÜLLER counter X-ray diffractometer has been built in this laboratory¹ for the quantitative analysis of mineral dusts. One of the first tasks of this apparatus was the measurement of quartz content in airborne dusts, lung residues and similar material arising in silicosis research. It was therefore necessary to examine the accuracy with which such determinations can be made, and in particular the effect on their accuracy of the particle-size of the quartz.

Closely graded size-fractions were prepared by repeated sedimentation or centrifuging; their size-distributions were determined by optical or electron microscopy, and the mean size $\bar{d}$ of each fraction expressed in the form $\bar{d} = \Sigma n d^3 / \Sigma n d^2$, where n_d is the number of particles in a small size-range of mean diameter d . The peak intensities of the 1122 line of quartz (spacing 1.82 Å.) are shown as a function of $\bar{d}$ in Fig. 1; they reach a maximum at $\bar{d} = 2\mu$ approximately, and fall off for $\bar{d}$ both larger and smaller than this value. The lower intensities for larger particle-sizes are to be expected as a result of extinction; those at smaller sizes are attributed to the existence of the 'amorphous layer' previously reported². The broken part of the curve refers to samples from which an attempt has been made to remove the 'amorphous' layer by etching with hydrofluoric acid. (The sizes of the etched samples were determined afresh by microscopy.)

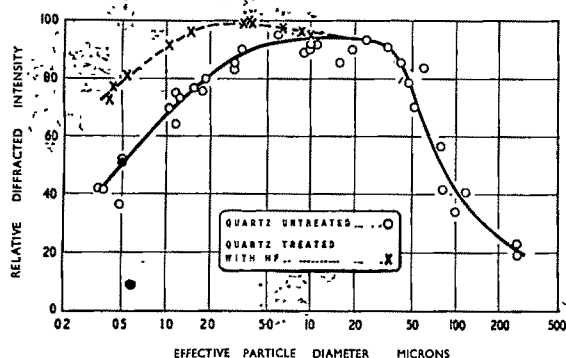


Fig. 1

The effects of this 'layer' have been since studied in detail, and results to be published elsewhere suggest that it is not a clearly defined amorphous shell surrounding perfectly crystalline material, but rather that a gradual increase in crystallinity occurs from the surface of a particle towards the interior. This idea is confirmed by the fact that for particles less than 0.5μ in size the full intensity of the diffraction line is not reached after etching; these particles are presumably too small for the crystal lattice to be undisturbed even at the centre. A few measurements, in which integrated areas of diffraction lines were measured, confirmed these observations; the total reduction in integrated intensity at small particle-sizes is somewhat less than that in peak intensity, since the peak measurement is affected to some extent by particle-size line-broadening; but it is not possible to account for the whole reduction in peak intensity in this way.

Thus in order to make accurate determinations of quartz by X-ray diffraction, it is necessary to know

its particle-size distribution and, possibly, whether it has received treatment equivalent to etching. In the size range 1–20 μ , the error introduced by ignoring these effects is of the order of 12 per cent; for correlation with medical studies this error is insignificant.

We wish to thank Mr. J. Cartwright of this laboratory, who determined the particle-size distributions, and to acknowledge the experimental assistance of Mr. B. Russell and Miss A. V. Sanderson. Our thanks are due to the Director of the Safety in Mines Research Establishment and the Ministry of Fuel and Power for permission to publish this communication.

R. L. GORDON
G. W. HARRIS

Safety in Mines Research Establishment,
Sheffield 1.
Feb. 28.

¹ Arndt, U. W., and Nelson, J. B., *Brit. J. App. Phys.*, **5**, 417 (1954).
Gordon, R. L., and Harris, G. W., *Safety in Mines Research Establishment Research Report No. 137* (in preparation).

² Nagelschmidt, G., Gordon, R. L., and Griffin, O. G., *Nature*, **169**, 539 (1952).
Gordon, R. L., Griffin, O. G., and Nagelschmidt, G., *Safety in Mines Research Establishment Research Report No. 52* (1952).

Unusual Waveguide Characteristics associated with the Apparent Negative Permeability obtainable in Ferrites

B AND H in a magnetized ferrite material are related, not by a scalar permeability, but by a tensor of the form:

$$\begin{vmatrix} \mu - jk & 0 \\ jk & \mu \\ 0 & 0 & \mu_z \end{vmatrix}$$

where z is the direction of the magnetization¹. If a plane wave is propagated along the z direction and is circularly polarized, the permeability associated with the transverse components in the xy plane assumes the form:

$$E_z = (\mu \pm k) H_t$$

where the sign depends on the direction of the circular polarization. In many ferrites at 10,000 Mc/s., k is greater than μ and the effective permeability for right-handed polarization about the field direction is negative. The propagation constant, which is proportional to the square root of the permeability, is imaginary and the wave is evanescent.

However, an interesting case occurs if such a wave is generated in a waveguide. In order that the electric field at the wall should be zero, a transverse variation of field arises, and for H -modes this is associated with the longitudinal permeability μ_z , which is of the order unity and is positive. If it is assumed that the transverse permeability $(\mu - k)$ is unaffected by the guide walls, which is qualitatively justified by the rigorous theory of Euhl and Walker², the propagation constant in the ferrite, γ_g , follows from the equation

$$\frac{\gamma_g^2}{k^2 - \mu} = \frac{\gamma_t^2}{\mu_z} - \gamma_0^2 \epsilon$$

where γ_0 is the free-space propagation constant and γ_t is inversely proportional to the size of guide, and ϵ is the dielectric constant of the ferrite. For a waveguide of very large size γ_g is imaginary, and the wave is evanescent. As the size of guide is reduced, so the attenuation decreases until a critical point is reached

corresponding to the cut-off in an isotropic material of permeability μ_z . Beyond this, γ_g becomes positive and the wave is propagated. This propagation should continue down to zero waveguide size, and the guide wave-length will decrease progressively and indefinitely. It can also be shown that the group velocity of the wave is negative and therefore that the wave travel is in the opposite direction to the energy flow.

Results of an experimental investigation on two sizes of ferrite-filled circular waveguide are shown in Fig. 1. The diameters were 1/8 in. and 9/16 in. respectively, below and above the cut-off diameter at 10,000 Mc./s. as normally calculated, assuming an isotropic permeability equal to μ_z . The attenuation is plotted against magnetic field. The full curves for positive field refer to the case where the effective transverse permeability is negative, and it is apparent that the attenuation is greater through the large-diameter waveguide. The dotted curve for negative field is of the normal type for positive permeabilities, and the small waveguide is beyond cut-off. It was also confirmed experimentally that in the anomalous propagation in the 1/8-in. diameter guide the phase velocity was negative.

Experiments were not carried out on the effect of varying the wave-length; but it would be expected that the small-diameter waveguides would continue to propagate as the frequency is reduced over the whole range that $\mu - k$ is negative. This lies between the gyromagnetic resonance frequency, given by $\omega = \gamma H$, and the inversion frequency given by $\omega = \gamma B$, where γ is the gyromagnetic ratio of the

electron, and H and B are the magnetic field and induction, respectively, in the ferrite.

G. H. B. THOMPSON
Standard Telecommunication Laboratories, Ltd.,
Progress Way, Great Cambridge Road,
Enfield, Middlesex. April 14.

¹ Polder, D., *Phil. Mag.*, 40, 99 (1949).

² Suhl, H., and Walker, L. R., *Bell System Tech. J.*, 33, No. 3, 579.

A Double-walled Vessel for the Distillation of Highly Inflammable Liquids

THE apparatus described below¹ provides a safe means of distilling or refluxing highly inflammable liquids. It has the added advantages of heat economy and the avoidance of bumping. The inner portion *A* of a double-walled vessel (Fig. 1) contains the liquid to be distilled or refluxed, *C*, and is connected by joint *G* to a condenser in the appropriate position. The outer portion *B* is connected to a reflux condenser *E* and contains, therefore, only a small amount of inert non-inflammable heating liquid *D*, with a boiling point slightly in excess of that of *C*. In view of the enclosed nature of the heating bath, a surprisingly small external heat source suffices, and very even heating of the entire vessel *A* occurs with little bumping.

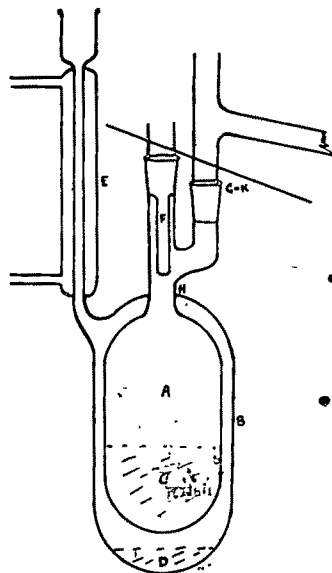


Fig. 1. *A*, internal flask, round or elongated, with all-glass sea at *H*; *B*, outer jacket; *C*, liquid for distillation; *D*, higher boiling point; *E*, water-jacketed condenser; *F*, thermometer pocket; *G*, ground joints; *H*, all-glass seal

Dimensions of the apparatus are not critical, though the distance between the bottoms of *A* and *B* should be sufficient to avoid direct contact of liquid *D* with vessel *A*.

The advantages of the apparatus are that fire risk is largely eliminated, since the simultaneous fracture of both vessels together is improbable; in this unlikely event, the inflammable liquid would be mixed immediately with the non-inflammable bath liquid. A break of vessel *A* or *B* only would not be dangerous.

C. C. SMITH

Department of Colloid Science,
University of Cambridge. Jan. 21.

¹ Provisional Brit. Patent No. 69407.

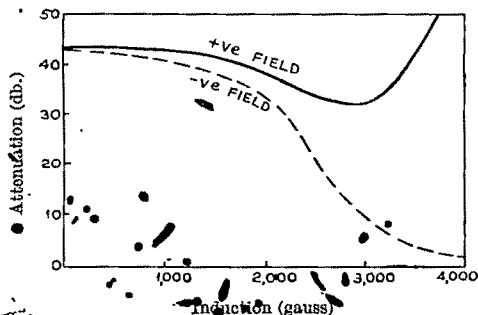
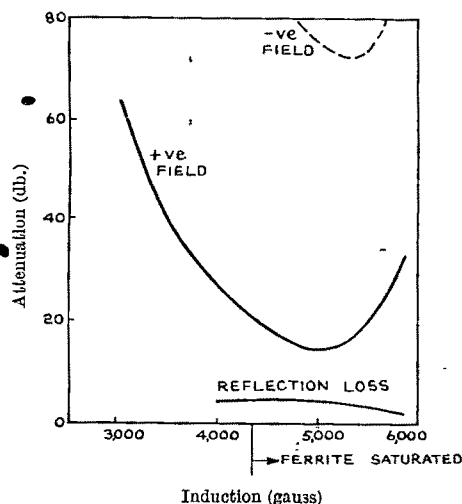


Fig. 1. Specimens of ferroxcube B2 at 10,200 Mc./s., with the following diameters: 0.125 in. (upper graph); 0.562 in. (lower graph)

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Tuesday, June 28

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1, at 7 p.m.—Dr. Gustav Jahoda: "Some Social Implications of Cultural Differences in Mental Abilities".

Tuesday, June 28—Saturday, July 9

BRITISH INSTRUMENT INDUSTRIES EXHIBITION (at Earls Court, London, S.W.).

Wednesday, June 29

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. M. H. P. Bott: "A Geophysical Study of the Granite Problem"; Mr. G. B. Thomas and J. M. Thomas: "The Volcanic Rocks of the Fishguard-Strumble Head Area, Pembrokeshire".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion on "The Micro-determination of Molecular Weight".

Thursday, June 30

INSTITUTE OF PETROLEUM (in arrangement with the U.S. CO-ORDINATING RESEARCH COUNCIL, at the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1), at 3.30 and 5.30 p.m.—Mr. M. K. McLeod, Mr. T. B. Rendel, Mr. E. S. MacPherson and Mr. W. J. Sweeney: "The Story of the Co-ordinating Research Council".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. J. R. Clarke: "Influence of Numbers on Reproduction and Survival in Two Experimental Vole Populations"; Mr. J. E. Morton: "The Functional Morphology of the British Ellobiidae".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHAIR OF MEDICINE tenable at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 28).

ASSISTANT EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (with a pass degree in chemistry or physics or equivalent qualification) at the Agricultural Research Council's Unit of Embryology at Bangor, to assist in serological investigations using radioactive isotopes—The Director, Unit of Embryology, University College of North Wales, Bangor (June 30).

ASSISTANT LECTURER (Taxonomist) IN THE DEPARTMENT OF BOTANY; an ASSISTANT LECTURER IN SOIL SCIENCE; an ASSISTANT LECTURER (with special interests in the theory of solids or metals) IN THE DEPARTMENT OF APPLIED MATHEMATICS; an ASSISTANT LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS; and an ASSISTANT LECTURER IN THE DEPARTMENT OF AGRICULTURE (Animal Husbandry)—The Registrar, University College of Wales, Aberystwyth (June 30).

ASSISTANT (with an honours degree in physiology or biochemistry) IN PHYSIOLOGY at St. Salvador's College—Joint Clerk to the University Court, College Gate, St. Andrews (June 30).

BIOCHEMIST (British nationality) with an honours degree in biochemistry or agricultural chemistry and at least five years postgraduate experience in biochemical work) IN THE VETERINARY RESEARCH DIVISION of the Ministry of Agriculture, Stormont, Belfast—The Secretary, Civil Service Commission, Stormont, Belfast (June 30).

BIOMETRICIAN (with either a first degree in mathematics with subsequent appropriate training in biology, or a degree in some branch of science with subsequent training in biometry and/or statistical and experimental method) IN THE DEPARTMENT OF AGRICULTURE—The Registrar, King's College, Newcastle-upon-Tyne (June 30).

RESEARCH FELLOW IN ASTRONOMY or ASTROPHYSICS—The Secretary, University College, Exeter (June 30).

RESEARCH OFFICER IN CYTOLOGY, and a DEPARTMENTAL DEMONSTRATOR IN CYTOLOGY—Prof. C. D. Darlington, Botany Department, The University, Oxford (June 30).

SECOND ASSISTANT ANALYST (with a degree or A.R.I.C.)—The Borough Analyst, Civic Centre, Southampton (June 30).

SENIOR BIOCHEMIST (with a first- or second-class honours science degree or A.R.I.C.) IN THE RESEARCH LABORATORY, RHUMATISM RESEARCH UNIT—The Secretary, Bath Hospital Management Committee, Manor Hospital, Bath (June 30).

ZOOLOGIST at the Dove Marine Laboratory—The Registrar, King's College, Newcastle-upon-Tyne (June 30).

ASSISTANT (with an honours degree in electrical engineering and preferably with research experience) IN THE DEPARTMENT OF ENGINEERING—The Secretary, The University, Edinburgh (July 1).

LECTURER IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (July 1).

ASSISTANT LECTURER (with qualifications in physical and inorganic chemistry) IN CHEMISTRY—The Registrar, The University, Hull (July 2).

ASSISTANT LECTURER (preferably female) IN ORGANIC CHEMISTRY—The Principal, Royal Holloway College, Englefield Green, Surrey (July 4).

ASSISTANT, Grade B (with a good honours degree in mathematics of a British university, and preferably with teaching experience)

IN THE DEPARTMENT OF MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11 (July 5).

ASSISTANT LECTURER (graduate in physics, chemistry, metallurgy, biology or engineering) IN DENTAL MATERIALS—The Registrar, The University, Manchester (July 6).

LECTURER IN AGRICULTURAL BOTANY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 6).

CHEMIST (with a good honours degree or equivalent qualification) IN THE COAL SURVEY LABORATORY, Newcastle-upon-Tyne, for analytical investigation work—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1 quoting SS/1 (July 7).

ASSISTANT, Grade B (with a good honours degree in chemistry and preferably with teaching experience)—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (July 9).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, The University, Sheffield (July 9).

ENGLISH ELECTRIC COMEANY RESEARCH FELLOW (graduate in engineering or applied science) IN AERONAUTICS—The Secretary of University Court, The University, Glasgow (July 9).

LECTURER IN GEOLOGY—The Registrar, The University, Nottingham (July 9).

LECTURER IN THE DEPARTMENT OF ELECTRONIC ENGINEERING, and a LECTURER IN THE DEPARTMENT OF ELECTRIC POWER ENGINEERING—The Registrar, The University, Liverpool (July 9).

LECTURER IN CHEMISTRY, an ASSISTANT LECTURER IN PHYSICS; an ASSISTANT LECTURER IN BIOLOGY; and an ASSISTANT LECTURER IN GEOLOGY at the Royal Technical College of East Africa, Nairobi—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (July 11).

ASSISTANT ZOOLOGIST (with an honours degree in zoology or specialized in entomology or plant nematology) for work in connexion with the beet eelworm and related species of cyst-forming nematodes and will include a study of population dynamics—The Secretary, School of Agriculture, University of Cambridge (July 13).

ASSISTANT LECTURER (Grade III) or DEMONSTRATOR IN PHARMACOLOGY—The Registrar, The University, Bristol 8 (July 15).

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN PHYSICS at the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, July 15).

LECTURERS (2) (with an honours degree) IN PHYSICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (July 15).

RESEARCH OFFICER—PHYSICIST (with a university honours degree in science with physics as a major subject, or equivalent qualifications, and some research experience in physics or physical meteorology) IN THE DIVISION OF METEOROLOGICAL PHYSICS, Commonwealth Scientific and Industrial Research Organization, Ascendale (near Melbourne), Victoria, for research into turbulent transfer processes in the atmosphere with emphasis initially on the experimental study of interchange of energy between atmosphere and ocean, including observational work at sea—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 470/73 (July 16).

SENIOR RESEARCH FELLOW (with Ph.D. or equivalent qualification, and preferably with some experience in cement chemistry and/or X-ray crystallography), and a JUNIOR RESEARCH STUDENT, IN THE DEPARTMENT OF CHEMISTRY, to carry out fundamental research on the chemistry of cement and cement products—The Secretary, Marischal College, University of Aberdeen (July 16).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university honours degree, with chemistry or chemical engineering or metallurgy as a major subject, and preferably with evidence of postgraduate experience and research ability) IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Melbourne, to conduct research into problems associated with the processing of a wide variety of Australian uranium ores—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 590/555 (July 16).

CHAIR OF CHEMISTRY tenable at Royal Holloway College—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 20).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Reading (July 22).

BOTANIST (preferably with an honours degree in agricultural botany and two years postgraduate experience, or at least a degree in agriculture) IN THE BOTANICAL DIVISION, Rubber Research Institute of Malaya, Kuala Lumpur, to take charge of field experiments and to assist with advisory work—The Secretary, Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (July 30).

RESEARCH OFFICER (with a university honours degree in science or agricultural science, research experience in pasture ecology and/or animal husbandry) IN THE LAND RESEARCH AND REGIONAL SURVEY SECTION, Commonwealth Scientific and Industrial Research Organization, Katherine, Northern Territory, to conduct studies on animal production based on the utilization of native pastures, supplemented by the by-products of a tropical dry monsoonal farming system—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 571/24 (July 30).

SENIOR LECTURER IN AGRICULTURE—The Secretary, West of Scotland Agricultural College, 6 Elythwood Square, Glasgow, G.2 (July 30).

JOHN HOLT DIRECTOR OF BIOCHEMICAL RESEARCH in the St. Vincent's Hospital School of Medical Research (University of Melbourne)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (August 20).

DIRECTOR (with high scientific attainments, administrative ability and experience) OF THE INDIAN INSTITUTE OF SCIENCE—The Registrar, Indian Institute of Science, Bangalore 3, India (September 5).

SENIOR LECTURER (with a good honours degree or higher degree in engineering and some experience in the application of the principles of applied mechanics and stress analysis to machinery and mechanical structures, and preferably with industrial experience) IN MECHANICAL ENGINEERING at the University of Queensland,

Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, 1955, p. 20).

ASSISTANT EXPERIMENTAL OFFICERS or EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent) at the Royal Aircraft Establishment, Farnborough, Hants, to assist in development of optical instrumentation used in guided weapons trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.395/5A.

ASSISTANT, Grade B, IN PHARMACEUTICAL CHEMISTRY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

BACTERIOLOGIST (university trained and with practical laboratory experience) to carry out laboratory work in connexion with the production of veterinary sera and vaccines—The Bayer Biological Institute, Exning, Newmarket.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (with H.S.C. or equivalent qualifications and preferably with a knowledge of physical chemistry and/or chemical engineering experience), to assist in investigations in the physico-chemical properties of high explosives, and in the application of the results to the production of charges on plant scale—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 284/WGE/34.

EXPERIMENTAL OFFICER (preferably with a degree in chemical engineering, or at least Inter.B.Sc. or H.N.C. in chemical engineering and experience in the operation of experimental plants and an understanding of chemical engineering principles), to take part in the design and development of special plants involving the testing of prototype equipment and assist in developing the final plant designs—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 578/WGE/34.

GRADUATE RESEARCH OFFICER (preferably well qualified in mineralogy) IN THE RESEARCH SECTION OF THE CHEMISTRY DEPARTMENT, for laboratory and field work on slag utilization—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Slags".

HEAD OF THE DEPARTMENT OF CHEMISTRY (including colour chemistry and dyeing)—The Principal, Technical College, Queen Street South, Huddersfield.

LECTURER AND ASSISTANT LECTURER IN APPLIED PHYSICS—The Secretary, Royal Technical College, Glasgow.

LECTURER (Grade II) IN BIOLOGICAL ENGINEERING—The Registrar, The University, Birmingham 15.

LECTURER IN MATHEMATICS; an ASSISTANT (Grade B) IN BIOLOGY; and an ASSISTANT (Grade B) IN PHYSICS—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

SENIOR LECTURER IN ELECTRONICS; a LECTURER IN ELECTRICAL MEASUREMENTS; and a LECTURER IN ELECTRICAL (Light-Current) ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research: Building Research Station, National Building Studies, Research Paper No. 21: Studies on Bridge-deck Systems. I: Tests on a Model Jack-Arch Slab. By A. Short and B. I. Lewis. Pp. vi+70+4 plates. (London: H.M. Stationery Office, 1955.) 4s. net. [284]

Nickel and Nickel Alloys in Electronic Valves. Pp. 20. (London: Henry Wiggin and Co., Ltd., 1955.) [284]

Building Research Station Digest No. 75: Strength and Stability of Walls. Pp. 7. (London: H.M. Stationery Office, 1955.) 3d. net. [284]

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 936, Vol. 247, (26 April 1955): An Electrically Calibrated Bomb Calorimeter. By A. B. Challenor, H. A. Gundry and A. R. Meehan. Pp. 553-582. 9s. No. 937, Vol. 248, (28 April 1955): The de Haas-van Alphen Effect. 3: Experiments at Fields up to 32 kG. By J. S. Dhillon and D. Schoenberg. Pp. 21-68. 6d. (London: Royal Society, 1955.) [284]

Privy Council. Medical Research Council Special Report Series No. 288: The Effect of Sugar Supplements on Dental Caries in Children. By J. D. King, May Mellanby, H. H. Stones and H. N. Green. Pp. viii+56. (London: H.M. Stationery Office, 1955.) 4s. net. [294]

Murphy Insecticides, Fungicides, Fumigants for Nurserymen. Pp. 124. (Wheatthampstead: Murphy Chemical Company, Ltd., 1955.) [29]

Department of Scientific and Industrial Research. Report of the Chemistry Research Board, with the Report of the Director of the Chemical Research Laboratory, for the year 1954. Pp. iv+71. (London: H.M. Stationery Office, 1955.) 3s. net. [294]

Fingerprints: Fifty Years of Injustice. By George Wilton Wilton. Pp. 16. (Galashiels: A. Walker and Son, Ltd., 1955.) 2s. [294]

British Non-Ferrous Metals Research Association. Thirty-fifth Annual Report, April 1955. Pp. 46. (London: British Non-Ferrous Metals Research Association, 1955.) [294]

Institute of Personnel Management. Occasional Papers No. 6: Techniques or Men? Pp. 11. (Originally published in the December 1954 issue of *Personnel Management*) Pp. 11. 2s. Some Principles of Training—Applied to the Retail Trade. By Elise Herzberg. (Broadcast Series.) Pp. 23. 3s. 6d. (London: Institute of Personnel Management, 1955.) [25]

Institute of Seaweed Research. Annual Report for 1954. Pp. 44 (3 prices). (Inverack, Midlothian: Institute of Seaweed Research, 1955.) [25]

Ministry of Education. Report of the Working Party on Grants to Training Colleges. Students. Pp. 28. (London: H.M. Stationery Office, 1955.) 1s. net. [25]

Petroleum Information Bureau, U.K. Petroleum Industry Statistics Relating to Consumption and Refinery Production, 1953 and 1954. Pp. 8. (London: Petroleum Information Bureau, 1955.) [25]
Journal of the Chemical Engineering Society of the University of Leeds. Vol. 1, No. 1 (March 1955). Pp. viii+39+ix. (Leeds: University, 1955.) [25]

Other Countries

Chronicle of the World Health Organization. Vol. 9, No. 4: The Work of WHO: 1954—a Review of the Annual Report of the Director General. Pp. 101-130. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 1s. 9d.; 0.30 dollars; 1 Sw. franc. [25]

United States Department of the Interior: Fish and Wildlife Service. Research Report 36: Noxious Marine Animals of the Central and Western Pacific Ocean. By Charles J. Fish and Mary Curtis Cobb. Pp. iii+46. 35 cents. Statistical Digest 31: Alaska Fishery and Fur Seal Industries—1951. By Seton H. Thompson. Pp. iv+70. 35 cents. Statistical Digest 32: Propagation and Distribution of Food Fishes for the Calendar Years 1951-1952. By Lee M. Duncan and O. Lloyd Meehan. Pp. ii+36. 20 cents. Statistical Digest 33: Alaska Fishery and Fur Seal Industries—1952. By Seton H. Thompson. Pp. iv+68. 35 cents. Circular 25: This is a Salmon Hatchery—Producing Salmon to Maintain Commercial and Sport Fisheries. Pp. 8. 5 cents. Circular 27: The Golden Eagle and Its Economic Status. By Lee W. Arnold. Pp. iv+35. 25 cents. Circular 28: A Visit to a Federal Fish Hatchery. Pp. 9. 10 cents. Wildlife Abstracts, 1935-51. (An annotated bibliography of the Publications abstracted in the Wildlife Review, Nos. 1-86.) Compiled by Neil Hotchkiss. Pp. iv+435. 2 dollars. Conservation in Action. No. 11: Arkansas—a National Wildlife Refuge. By Julian A. Howard. Pp. 12. 15 cents. (Washington, D.C.: Government Printing Office, 1954.) [25]

United States Department of the Interior: Fish and Wildlife Service. Fishery Bulletin 89, (Vol. 55): Gulf of Mexico—its Origin, Waters, and Marine Life. Prepared by American scientists under the sponsorship of the Fish and Wildlife Service, U.S. Department of Interior. Coordinated by Paul S. Galtsoff. Pp. xiv+604. 3.25 dollars. Fishery Bulletin 90, (Vol. 56): Studies of Georges Bank Haddock. Pt. 2: Prediction of the Catch. By William F. Royce and Howard Schuck. Pp. ii+6. 10 cents. Fishery Bulletin 91, (Vol. 56): Fluctuations in Growth and Year-Class Strength of the Walleye in Saginaw Bay. By Ralph Hile. Pp. ii+7-60. 35 cents. Fishery Bulletin 92, (Vol. 56): Mortality of Salmon Fingerlings Exposed to Pulsating Direct Current. By Gerald B. Collins, Charles D. Volz and Parker S. Trefethen. Pp. ii+61-82. 30 cents. Fishery Bulletin 93, (Vol. 56): Distribution and Abundance of Egg and Larval Populations of the Pacific Sardine. By Elbert H. Ahlstrom. Pp. ii+83-140. 40 cents. Fishery Bulletin 94, (Vol. 56): Method of Estimating Fish Populations with Application to Pacific Sardine. By T. M. Widrig. Pp. ii+141-160. 30 cents. Fishery Bulletin 95, (Vol. 56): Intertidal Spawning of Pink Salmon. By Mitchell G. Hanavan and Bernard Einar Skud. Pp. ii+167-186. 15 cents. Fishery Bulletin 96, (Vol. 56): Whiting on the Coasts of the American Continents. By Isaac Ginsburg. Pp. ii+187-208. 20 cents. Fishery Bulletin 97, (Vol. 56): Description of Eggs and Larvae of Jack Mackerel (*Trachurus symmetricus*) and Distribution and Abundance of Larvae in 1950 and 1951. By Elbert H. Ahlstrom and Orville P. Ball. Pp. ii+209-248. 30 cents. Fishery Bulletin 98, (Vol. 56): Feeding Mechanism of the Sea Lamprey and Its Effect on Host Fishes. By Robert E. Lannon. Pp. ii+247-294. 40 cents. (Washington, D.C.: Government Printing Office, 1954.) [35]

National Academy of Sciences—National Research Council. Nuclear Science Series. Report Number 17: Biochemical Aspects of Basic Mechanisms in Radiobiology. Edited by Harvey M. Patt. (Proceedings of an Informal Conference held at Highland Park, Illinois, May 13-15, 1954.) (Publication 387 in the Academy Research Council series of scientific and technical publications.) Pp. ix+158. (Washington, D.C.: National Academy of Sciences—National Research Council, 1954.) 1.50 dollars. [51]

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 36, No. 2 (March 1955): The Increasing Chances of Survival. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [52]

University of California Publications in Zoology. Vol. 54, No. 2: Natural History of the Salamanders of the Plethodontid Genus *Ensatina*. By Robert C. Stebbins. Pp. 47-124. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1954.) 1.25 dollars. [52]

United States Department of Agriculture. Home and Garden Bulletin No. 44: Cabbage Insects—How to Control Them in the Home Garden. Pp. 6. (Washington, D.C.: Government Printing Office, 1955.) 5 cents. [53]

Bulletin of the American Museum of Natural History. Vol. 100: Article 1: A Revision of the Genus *Trox* in North America (Coleoptera: Scarabaeidae). By Patricia Vaurie. Pp. 1-90. (New York: American Museum of Natural History, 1955.) 1.25 dollars. [53]

American Philosophical Society. Year Book, 1954. Pp. 605. (Philadelphia: American Philosophical Society, 1955.) [53]

Annals of the New York Academy of Sciences. Vol. 59, Article 6: Leukoecytic Functions. By A. S. Gordon and 33 other Authors. Pp. 665-1070. (New York: New York Academy of Sciences, 1955.) 4.50 dollars. [53]

United States Department of Commerce. National Bureau of Standards. N.B.S. Circular No. 539: Standard X-ray Diffraction Powder Patterns. By Howard E. Swanson, Ruth K. Fuyat and George M. Ugrinic. Pp. ii+76. (Washington, D.C.: Government Printing Office, 1955.) 45 cents. [53]

Bulletin of the American Museum of Natural History. Vol. 100: Article 2: The Type Material in the J. B. Smith and G. D. Hulst Collections of Lepidoptera in the American Museum of Natural History. By Frederick H. Rindge. Pp. 91-172. (New York: American Museum of Natural History, 1955.) [53]

Technical Information Services in Europe: Report on the First Meeting of Technical Information Officers, held in the Department of Scientific and Industrial Research, London, from 27th September to 1st October, 1954. Pp. 69. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1955.) [53]